Section I
Total Marks (75)

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

Use the multiple choice answer sheet.
Select the alternative A, B, C or D that best answers the question. Fill in the response square completely.

Sample 2+4= (A) 2 (B) 6 (C) 8 (D)9

A • B ζ C • D •

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ζ B ζ C • D •

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

correct

A ζ B ζ C • D •

SECTION I
Part A
Multiple Choice

1. The extraction of copper from copper(I) sulfide produces sulfur dioxide as a by-product according to the equation:

$$Cu_2S(s) \quad + \quad O_2(g) \quad \rightarrow \quad 2\ Cu(s) \quad + \quad SO_2(g)$$

What volume of sulfur dioxide gas will be released at 25^0C & 101.3 kPa when 2.2 g of copper (I) sulfide is reacted?

(A) 338 mL
(B) 563 mL
(C) 10 mL
(D) 515 mL

2. Which acid below is not naturally occurring?

(A) 2-hydroxypropane-1,2,3-tricarboxylic acid
(B) HCl
(C) HBr
(D) CH_3COOH

3. $H_2PO_4^-$ is an amphiprotic species.
Which of the following represents the conjugate acid and conjugate base respectively of $H_2PO_4^-$?

(A) H_3PO_4 and HPO_4^{2-}
(B) PO_4^{3-} and H_3PO_4
(C) H_3PO_4 and HPO_4^-
(D) HPO_4^{2-} and H_3PO_4

4. If equal volumes of the following aqueous solutions were mixed, which one would have the highest pH?

(A) 1 mol L^{-1} NaOH + 1 mol L^{-1} CH_3COOH
(B) 1 mol L^{-1} NH_3 + 1 mol L^{-1} H_2SO_4
(C) 1 mol L^{-1} H_2SO_4 + 1 mol L^{-1} $Ba(OH)_2$
(D) 1 mol L^{-1} KOH + 1 mol L^{-1} HCl

5. 25 mL of a solution of H_2SO_4 that has a pH of 3 is pipetted into a 250 mL volumetric flask and distilled water added up to 250 mL. What is the pH of the diluted solution?

(A) 0.5
(B) 4.5
(C) 4
(D) 5

6. In the Haber process , which of the following conditions would result in an industrially acceptable method of increasing the yield of ammonia?

(A) increasing the temperature of the reaction chamber
(B) channelling the ammonia to a cooling chamber
(C) increasing the amount of $N_2(g)$
(D) increasing the amount of $H_2(g)$

7. In the production of ammonia using the Haber process, which of the following statements is incorrect?

(A) At equilibrium, the yield is higher when the temperature is lower.
(B) Before reaching equilibrium, the rate is higher at a higher temperature.
(C) The rate of the reaction is lower at a higher temperature because the reaction is exothermic.
(D) At equilibrium, the yield is lower at a lower pressure.

8. In a water treatment plant, the monitoring system for the quantity of the flocculant added to the water system malfunctioned with less than the recommended amount being added to the water.
What would be the effect of this on the water quality?

(A) an unusually high bacterial count
(B) a high value of TDS (Total Dissolved Solids)
(C) a water supply with a pH between 8 and 9
(D) a water supply of high turbidity

9. Which of the following pairs of compounds are isomers?

(A) 1,2-difluorobutane and 1-fluorobutane
(B) 3-chloro-2-methyl-2-pentene and 1-chloro-1-hexene
(C) 2-bromopropane and 2-bromo-2-propene
(D) 1,2-difluorobutane and 1,2-dichlorobutane

10. The concentration of ozone in the troposphere is 0.000002% (v/v). What is this concentration in parts per million (ppm) ?

(A) 0.0002
(B) 0.002
(C) 0.02
(D) 20

11. Which of these displacement reactions can occur spontaneously?

(A) $2\ Ag(s) + Cu^{2+} \rightarrow 2\ Ag^{+} + Cu(s)$
(B) $Sn^{2+} + Pb(s) \rightarrow Pb^{2+} + Sn(s)$
(C) $Fe(s) + Mg^{2+} \rightarrow Fe^{2+} + Mg(s)$
(D) $2\ Al^{3+} + 3\ Ni(s) \rightarrow 2\ Al(s) + 3\ Ni^{2+}$

12. The vanadium redox cell currently under development at UNSW acts as a galvanic cell during the reaction,

$$V^{2+} + VO_2^{+} + 2\ H^{+} \rightarrow V^{3+} + VO^{2+} + H_2O$$

Which of the species below is the reductant in this reaction?

(A) V^{3+}
(B) VO_2^{+}
(C) H^{+}
(D) V^{2+}

13. The reaction shows the production of ethanol from ethene.

$$C_2H_4 + H_2O \rightleftharpoons C_2H_5OH$$

Which of the following conditions are necessary for this reaction?

(A) warmth, yeast
(B) heating, refluxing
(C) heating, fractional distillation
(D) heating, pressurising, sulfuric acid catalyst

14. Which of the following represent the empirical formulas of polyethene and polyvinyl chloride?

(A) CH_2 and CHCl
(B) CH_2 and C_2H_3Cl
(C) $(CH_2{=}CH_2)n$ and $(CH_2{=}CHCl)n$
(D) $(CH_2{=}CH_2)n$ and $(CH_2{=}CCl_2)n$

15. The equation shows the bombardment of U-235 with a neutron which initiates a fission reaction,

$$^{235}_{92}U \quad + \quad ^{1}_{0}n \quad \rightarrow \quad ^{147}_{56}Ba \quad + \quad X \quad + \quad 3\ ^{1}_{0}n$$

Which of the following correctly identifies species X?

(A) Kr-36
(B) Kr-91
(C) Pa-91
(D) Np-93

Student Number ....

Answer Sheet
Section I
Part A

1.	A ζ	B •	C •	D •
2.	A •	B •	C ζ	D •
3.	A ζ	B •	C •	D •
4.	A ζ	B •	C •	D •
5.	A •	B •	C ζ	D •
6.	A •	B ζ	C •	D •
7.	A •	B •	C ζ	D •
8.	A •	B •	C •	D ζ
9.	A •	B ζ	C •	D •
10.	A •	B •	C ζ	D •
11.	A •	B ζ	C •	D •
12.	A •	B •	C •	D ζ
13.	A •	B •	C •	D ζ
14.	A •	B ζ	C •	D •
15.	Aζ	B •	C •	D •

JAMES RUSE AGRICULTURAL HIGH SCHOOL
2002 CHEMISTRY TRIAL HSC EXAM
Section I (continued)

Part B - 60 marks
Attempt Questions 16 -28
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

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MARKS

Question 16 (3 marks)

A 5.00 mL volume of vinegar was found to weigh 4.50 g. The vinegar was placed into a conical flask and diluted with 20.0 mL of distilled water. The concentration of acetic acid (ethanoic acid) in the vinegar was determined by titration with 0.100 mol L^{-1} sodium hydroxide. At the endpoint, the titre was 23.3 mL.

(a) Calculate the percentage mass of acetic acid in the original undiluted vinegar. **2**

Criteria	Mark
mole CH_3COOH = mole NaOH = (0.100 molL^{-1})(0.0233 L) = 2.33 x 10^{-3} mol mass CH_3COOH = mole x molar mass = 2.33 x 10^{-3} mol x [2(12.01) + 2(16.00) + 4(1.008)] = 0.13992 ~ 0.140 g % CH_3COOH =(mass/volume) 100% = $\frac{0.140}{5.00}$ x 100 = **2.8%**	2
Coreect calculations	

(b) What is the concentration (mol L^{-1}) of acetic acid in the undiluted vinegar? **1**

Criteria	Mark(s)
[CH_3COOH] = mole CH_3COOH/vol in L = 2.33 x 10^{-3} mole/0.005L **= 0.466 mole/L**	1
Correct calculation	1

Question 17 (3 marks)

(a) (i) Explain why ammonium chloride can form an acidic solution in water and therefore classified as an acidic salt. Use equation(s) in your answer. **1**

Criteria	Mark(s)
The NH_4^+ ion is a better proton donor, ie a stronger acid than water and hence, is able to donate a proton to water to increase H_3O^+ concentration in water. $NH_4^+ + H_2O \Leftrightarrow NH_3 + H_3O^+$	1
any answer with a similar reasoning	1

(ii) Explain why sodium hydrogen carbonate can form a basic solution in water and is therefore classified as a basic salt. Use equation(s) in your answer. **1**

Criteria	Mark(s)
The HCO_3^- ion is amphiprotic substance but tends to accept rather than donate protons to water. Abstraction of a proton from water results in a basic solution $HCO_3^- + H_2O \Leftrightarrow H_2CO_3 + OH^-$. Free OH^- ions in solution make the solution basic	1
any similar reasoning with an equation	1

(b) Name a salt which should form a neutral solution in water. **1**

Criteria	Mark(s)
Sodium chloride	1
any other neutral salt	1

MARKS

Question 18 (8 marks)

During your course, you determined the heat of neutralisation of an acid. . Describe the procedure you followed and justify the appropriateness of the procedure you adopted in order to obtain valid and reliable results. . **8**

Criteria	Mark(s)
The heat of neutralisation is the heat released when 1 mole of an acid is neutralised with 1 mole of a base *eg* $HCl + NaOH \rightarrow NaCl + H_2O(l)$ or $H^+ + OH^- \rightarrow H_2O(l)$ ΔH_{neut} = (-) exothermic	1
The experiment was done in the following manner: ~ 50.0mL of 1.00molL^{-1} HCl was pipetted into a polystyrene cup and its temperature measured and recorded. ~ 50.0mL of 1.00molL^{-1} HCl was placed into a 50.0mL burette and its temperature measured and recorded ~ The NaOH solution was then added to the HCl solution; stirred (carefully) with the thermometer and the maximum temperature reached noted. The mixture was stirred before recording the temperature to avoid recording localised temperature changes as those of the bulk of the solution.	3
A polystyrene cup (good insulator) is used to prevent heat transfer through the walls of the container. Accurate measurements of volumes, use of pipette and burette is needed for an accurate calculation of mass of solution and number of moles of acid or base. Repeating the experiment several times could add to the reliability of the results. The acids and the bases were both accurately known by standardisation so when ΔH is calculated, $\Delta H = (mCg\Delta t)/n$. the value of n is an accurate one. The initial temperatures of the NaOH and the HCl may differ hence, the initial temperatures of the HCl and the NaOH were determined and averaged.. Assumption of a density of 1g/mL for water incurred very little error or a databook. Alternatively, a data book could have been consulted for the density of water at specific temperatures.	4
Heat of neutralisation is defined , appropriate equations given or heat of neutralisation explained without equations. Detailed procedure is given and with an analysis of the procedure	8

MARKS

Question 19 (4 marks)

Naturally occurring citric acid has the molecular formula $C_6H_8O_7$. Like all acids, it reacts with carbonate solutions to form carbon dioxide gas. When 1.537 g citric acid was added to a solution containing excess sodium carbonate, 295 mL carbon dioxide (measured at 25^0C and 101.3 kPa) was formed.

(a) Write an equation for the reaction of hydrogen ions with carbonate ions. How many moles of carbon dioxide were formed? **2**

Criteria	Mark(s)
$2H^+ + CO_3^{2-} \rightarrow H_2O + CO_2(g)$ Moles CO_2 = volume CO_2/molar volume at SLC = 0.295L/24.47L/mole = **0.0121** moles	1 1

(b) Determine the number of moles of hydrogen ions produced by 1.537 g citric acid. **1**

Criteria	Mark(s)
Moles H^+ = 2 x moles CO_2 = 2 x 0.0121 = 0.0242 moles Moles of citric acid = 1.537g/[6(12.01) + 8(1.008) + 7(16.00)]g/mole = **8.01 x 10^{-3}** Moles H^+ = moles H^+ from citric acid?	1

(c) How many replaceable hydrogens (acidic hydrogens) are there in citric acid? Explain your answer. **1**

Criteria	Mark(s)
Moles of H^+ by stoichiometry = 0.0242 while Moles of citric acid = 8.01 x 10^{-3} There is 3 times as much H^+ reacting with CO_2 as there are moles of citric acid, therefore, there are 3 replaceable hydrogens in citric acid.	1

MARKS

Question 20 (2 marks)

Using ethanoic acid and nitric acid in your answer. Draw diagrams to represent:
(a) a concentrated, weak acid solution. (b) a strong, dilute acid solution **2**

Make sure you use correct formulas in your diagrams.

concentrated weak acid solution

strong, dilute acid solution

MARKS

Question 21 (6 marks)

(a) Describe the procedure you used to quantitatively analyse a manufactured product **4**

Criteria	Mark(s)
Analysis of citric acid in orange juice. Exactly 25.00mL of orange juice was pipetted into a conical flask. The pipette was previously rinsed with orange juice and the conical flask, rinsed with demineralised water. The orange juice was titrated with standard NaOH solution with phenolphthalein as the indicator. The NaOH solution was added until the yellow solution turned orange. The number of moles of citric acid = 3 times the number of moles of NaOH; $H_3Cit + 3NaOH \rightarrow Na_3Cit + 3H_2O$	4
Complete procedure including equation(s), the principle behind the analysis and the stoichiometry of the reaction	4

(b) Identify one problem you encountered in the procedure. **1**

Criteria	Mark(s)
One problem is the difficulty in judging the endpoint of the titration since the orange juice is itself highly coloured	1
any valid problem	1

(c) Propose a solution to this problem. **1**

Criteria	Mark(s)
A solution to this problem is the use of a pH glass electrode to monitor the titration. The electrode should be rinsed well after the titration to prevent any orange juice component from fouling the glass membrane	1
any reasonable solution to the analysis problem given in (b)	1

MARKS

Question 22 (3 marks)

Evaluate the effectiveness of atomic absorption spectrophotometric (AAS) measurements in pollution control. **3**

Criteria	Mark(s)
Metal ions can be dangerous pollutants even at low levels. Therefore, studies utilising AAS are very effective in pollution control because of the ability of AAS to detect metal ions at either very low or very high levels. For very low levels, pre-concentration methods such as solvent extraction or solvent evaporation may be done. Normally, the sample is simply directly introduced into the instrument without pre-separation. Interference problems are minimal. This is due to the inherent selectivity of the AAS technique which uses a specific hollow cathode lamp for each target ion. Samples containing high levels of metal ions can be diluted to suit the requirements of the instrument and the techniques.	3
The selectivity, low detection limit and ease of introducing the sample into the instrument should be included.	3

MARKS

Question 23. (6 marks)

Describe the test for the biochemical oxygen demand (BOD) and evaluate its importance with respect to the monitoring of the possible eutrophication of waterways. **6**

Criteria	Mark(s)
Two identical water samples are collected and analysed for dissolved oxygen by the same technique 5 days apart. After collection both samples are protected from light and oxygen exposure. Dissolved oxygen is analysed with the oxygen electrode or the Winkler titration technique. The difference in the dissolved oxygen level (DO) between the two samples is the biochemical oxygen demand (BOD) of the water sample. BOD is a measure of the concentration of dissolved oxygen needed for the complete breakdown of the organic matter in the water by aerobic bacteria which in turn uses up oxygen and at the same time raises the nutrient level of the waterway. These result in the depletion of oxygen, development of unpleasant odour and colonies of undesirable organisms such as algae. When these organisms are broken down, further degradation and eutrophication of the waterway result. Along with other tests, monitoring the BOD indicates the level of organic nutrients in the water. The level of organic nutrients can indicate possible contamination with sewage making it unfit for consumption and also can indicate the possibility of an enhaced rate of eutrophication in that waterway.	6
Test for BOD described	3
Role of BOD in eutrophication and importance of monitoring BOD	3

MARKS

Question 24 (5 marks)

Discuss the problems associated with the use of CFCs and the steps taken to alleviate these problems. **5**

Criteria	Mark(s)
The main problem associated with the use of CFCs is their ability to destroy ozone in the stratosphere. CFCs are broken down in the stratosphere under the influence of UV radiation to produce chlorine free-radicals which can destroy ozone. The destruction of the Earth's radiation "shield", the ozone layer, exposes the Earth's surface to dangerous levels of ozone which can cause cell damage in both plants and animals, in humans leading to skin cancers and cataracts. The CFCs are also greenhouse gases which contribute to global warming leading to global erratic weather patterns. The Montreal Protocol in its various versions aimed to alleviate these problems by halving and later on totally banning the manufacture of CFCs, the encouragement of the use of CFC replacementss which are planned to be phased out as well and the setting up of funds to help third world countries phase out CFCs.	5
Problems associated with CFCs	3
Montreal protocol regulations	2

MARKS

Question 25 (5 marks)

(a) A student prepares 250 mL of a 5% (w/v) glucose solution and adds 1 gram of yeast. Write a balanced chemical equation for the fermentation which occurs. **1**

Criteria	Mark(s)
$C_6H_{12}O_6$ -------> $2\ CO_2(g)$ + $2\ C_2H_5OH$	1
Yeast enzymes must be included to obtain the mark	1

(b) Calculate the mass of ethanol produced. **2**

Criteria	Mark(s)
mass of glucose = (0.05 g/mL) x 250 mL = 12.5 g mole C_2H_5OH = 2 x moles $C_6H_{12}O_6$ $= 2 \times \frac{12.5}{6(12.01)+12(1.008)+6(16.00)}$ = 0.1388 ~ **0.139 mole**	1
mass of C_2H_5OH = mole of C_2H_5OH x molar mass = 0.139x[2(12.01) +6(1.008) + 16.00] = **6.36 g**	1

(c) Describe conditions which promote fermentation. **1**

Criteria	Mark(s)
Warm temperature, ~ 37^0C as well as neutral pH and the presence of yeast enzymes promote fermentation	1
At least two conditions should be given to obtain the mark.	1

(d) Relate the structure of the ethanol molecule to its use as a solvent. **1**

Criteria	Mark(s)
The ethanol molecule is a good solvent for polar substances because it is a polar molecule. The highly electronegative oxygen depletes the carbon and the hydrogen of electrons making them partially positive and itself, partially negative. It is able, therefore to dissolve polar substances by dipole-dipole interaction or hydroxylated substances by hydrogen bonding	1
any reasonable explanation	1

MARKS

Question 26 (6 marks**)**

Using examples of named polymers, compare and contrast addition polymerisation with condensation polymerisation. Make reference to the sources of reactants and the and the processes used in their manufacture. **6**

Criteria	Mark(s)
Addition polymerisation and *condensation* polymerisation both involve the combining together of small molecules (monomers) to form one large molecule (polymer). They differ in many respects: Ÿ *Addition* polymerisation may either utilise an initiator or a catalyst for polymerisation whereas no general catalyst is utilised in condensation polymerisation. Ÿ The monomers in *addition* polymerisation are normally identical, for example for polyethene, ethene is the only monomer used in the manufacture of polyethene: $nCH_2{=}CH_2 + CH_2{=}CH_2 \rightarrow -CH_2(CH_2\text{-}CH_2)_n\text{-}CH_2\text{-}$ whereas in *condensation* polymerisation, the monomers may be identical as in nylon, (6-aminohexanoic acid) or different as in the manufacture of polyester from ethylene glycol and terephthalic acid. Ÿ No other product is formed in *addition* polymerisation whereas a small molecule, for example, H_2O or NH_3 is produced in *condensation* polymerisation. Ÿ Reactants (ethene, mainly) in *addition* polymerisation are obtained from the cracking of petroleum while those of *condensation* polymerisation may come from the degradation of polymers of biological origins such cellulose or are industrially synthesised.	6
Discussion of similarity	1
Discussion of differences	3
Sources of monomers	2

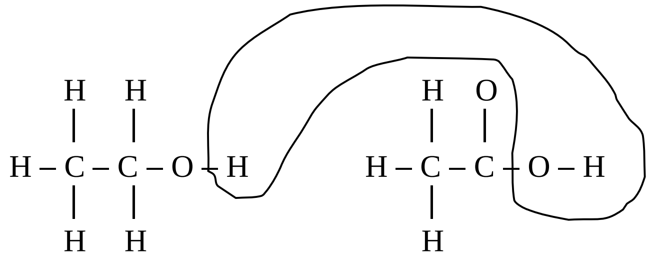
MARKS

Question 27 (4 marks)

(a) Give a reason why some nuclei are unstable. **1**

Criteria	Mark(s)
proton to neutron ratio is too high or too low or the atom is too heavy (Z> 83)	1

(b) The reaction mechanism for esterification was studied and verified using a tracer. It was proved that water was formed from an H from the alcohol and an OH from the acid.



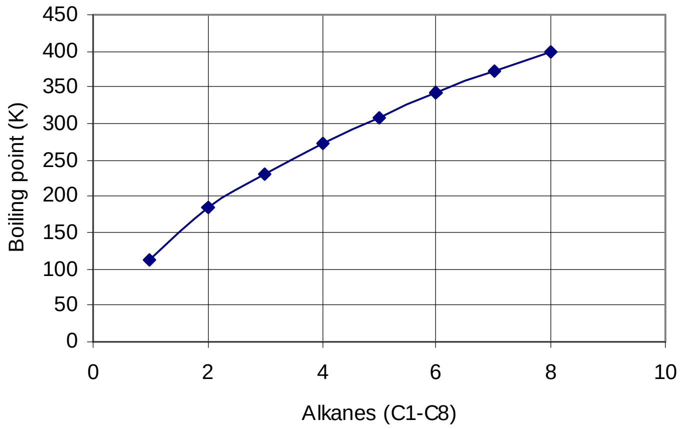
Identify a named radioisotope which could have been used in this research. **1**

Criteria	Mark(s)
oxygen-18, deuterium or tritium	1

(c) Cobalt-60 is a multi-purpose commercial radioisotope.
Describe how a non-transuranic isotope like cobalt-60 can be produced in a nuclear reactor and give an equation to illustrate your answer. **2**

Criteria	Mark(s)
A non-transuranic isotope such as cobalt-60 can be produced by irradiating a stable isotope such as cobalt-59 with neutrons in a nuclear reactor. ${}^{59}_{27}\text{Co} + n \rightarrow {}^{60}_{27}\text{Co}$ Cobalt-60 decays to produce β and γ radiations.	2
Description of process	1
equation	1

Question 28 (5 marks) **MARKS**



The graph shows the boiling points of the alkane series from methane to octane.

(a) Identify which gaseous alkane (plotted on the graph) would be the easiest to liquefy and give a reason for your answer. **2**

Criteria	Mark(s)
Butane, the gas with the highest boiling point and hence the easiest to liquify. If all gases were cooled it will be the first to reach its "condensation" temperature which is the same as its boiling point.	2
Butane	1
explanation of choice	1

(b) Sketch a curve on the graph showing the relative boiling points of the alkanoic acids from ethanoic acid to hexanoic acid in relation to the corresponding alkanes. **1**

Criteria	Mark(s)
as indicated in the graph	1

(c) Explain the difference in the boiling points of the alkanes versus the alkanoic acids **2**

Criteria	Mark(s)
The alkanes have only weak *dispersion forces* between molecules and hence require only a small amount of energy to separate them. However, alkanoic acids are extensively hydrogen-bonded to each other, hydrogen bonding is a stronger intermolecular force than *dispersion forces* and hence require more energy to separate the molecules from each other, *i.e.,* higher boiling point.	2
discussion of two forces	2

Section II 25 marks

Question 29. (25 marks) **MARKS**

(a) Describe the work of Davy and Faraday in increasing the understanding of electron transfer reactions. **4**

Criteria	Mark(s)
Davy discovered electrolysis, the use of electricity to break down substances chemically. His contribution includes the electrolysis of sodium and potassium, a technique using electron-transfer processes. He demontrated these procedures without specifically explaining them.	2
Faraday quantified electrolysis with his laws. He related the mass of substances produced and the amount of electricity passing through.	2

(b) Various methods can be used to protect the hulls of ships from corrosion. Explain **four** different methods that are used for protection. **8**

Criteria	Mark(s)
Four different methods used to protect the hulls of ships from corrosion are:	
Ÿ Painting the hull of a ship with new polymer paints such as the *Rustmaster Pro*. This paint forms a smooth impermeable (to oxygen and water) layer on the surface of the hull. It also incorporates additives that react with the surface to form a very insoluble ionic substance *pyroaurite*. This layer prevents ion migration on the surface and in conjunction with the polymer surface shields the surface from oxygen and water, thus, inhibiting corrosion.	2
Ÿ Hulls of ships are bombarded with metal ions such as Ni and Cr in the plasma state. These metal ions form surface alloys on the surface of the hulls to form a "stainless steel " - like finish. The protection is similar to the surface passivation afforded by alloying metals such as Cr and Ni in stainless steel.	2
Ÿ Cathodic protection may be employed to protect the hulls of ships. This is done by attaching an active metal *i.e.* one which has a more negative reduction potential than iron (such as Zn and Mg) to the hull of the ship. These metals, because of their greater reactivity act as sacrificial anodes. The hull becomes the cathode and the active metal becomes the sacrificial anode. The reactions are: $O_2 + 2H_2O + 4e^- \rightarrow 4\,OH^-$ cathode reaction $Mg(s) \rightarrow Mg^{2+} + 2e^-$ anode reaction	
Ÿ An impressed current may be applied to the hull of the ship with an inert anode and the ship's hull as the cathode. Any Fe^{2+} ions are reduced as well as O_2 (The reduction of oxxygen is the main reduction process. The reactions are: $O_2 + 2H_2O + 4e^- \rightarrow 4\,OH^-$ cathode reactions $Fe^{2+} + 2e^- \rightarrow Fe(s)$ $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$ anode reaction at the inert electrode	2

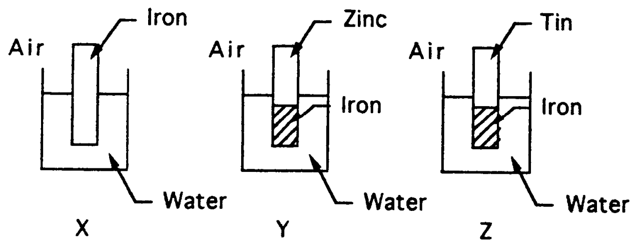
(c) Describe a passivating metal. **1**

Criteria	Mark(s)
A passivating metal is a reactive metal that readily forms an unreactive surface coating with substances such as O_2 and H_2O	1

(d) Compare the concentrations of gases normally dissolved in the oceans to their concentrations in the atmosphere. How do the solubilities of these 'soluble' gases vary with ocean depth? Explain. **4**

Criteria	Mark(s)
The concentration of O_2 in the atmosphere is about 30 times more than its concentration in the surface waters of the ocean. CO_2 on the other hand is so much more soluble in ocean water than oxygen is with about 90% as much concentration as atmospheric levels.	2
With ocean depth, the solubility of these gases should increase because of the dual positive effect of temperature and pressure on solubility. As depth increases, temperature decreases and hence, in general, gas solubility increases. Similarly an increase in solubility should result from an increase in pressure which results from increased depth. However, actual concentrations of the gases on the surface waters of the ocean are still higher than the bulk of the ocean waters because of immdiate contact with the atmosphere, the main source of these gases and because of the inefficient mixing of surface waters with the bulk of the water of the ocean.	2

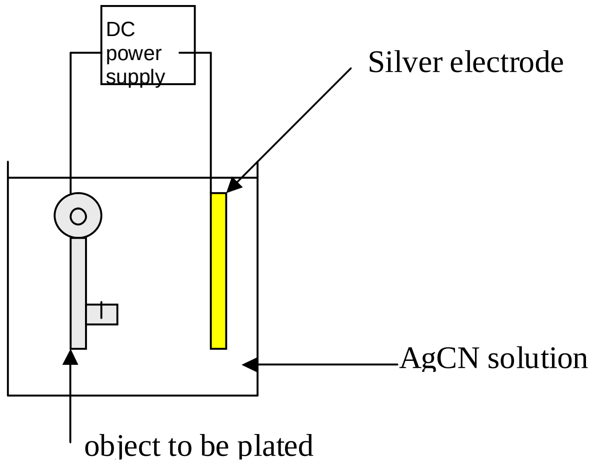
(e) Three experiments represented in diagrams *X*, *Y*, and *Z* were set up.



In which of these experiments, all at the same temperature, will the iron corrode the most and which will corrode the least? Explain your answer. **4**

Criteria	Mark(s)
Set-up *Z* will have the iron corroding most. This is because in contact with tin, iron act as the anode and the tin as the cathode. This is due to the greater tendency of iron (E^0_{red} = -0.44 v) *i.e.* more negative reduction potential, to be oxidised compared with Sn, (E^0_{red}=-0.14 v).	2
The set-up which will corrode least is *Y*. Zinc in contact with iron protects the iron from corrosion by acting as the sacrificial anode in the "corrosion" galvanic cell. This is due to the greater reactivity of zinc (E^0_{red}= -0.76 v) compared with iron (E^0_{red}=-0.44 v). The reaction in set-up *Y* is anode: $Zn(s) \rightarrow Zn^{2+} + 2e^-$ cathode: $O_2 + H_2O + 4e^- \rightarrow 4\ OH^-$	2

(f) Silver plated objects are obtained in an electrolytic cell in which the object is one electrode. The other electrode is a block of silver, and silver cyanide solution, AgCN, (actually, $Ag(CN)_2^-$ complex) is the electrolyte. The cell is illustrated below:



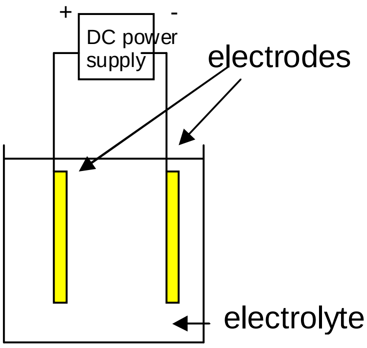
(i) Write a balanced equation to represent the oxidation process. At which electrode does this occur? **1**

Criteria	Mark(s)
$Ag(s)$ ® Ag^{+} + e^{-} or $Ag(s) + 2CN^{-} \rightarrow Ag(CN)_2^{-} + e^{-}$	1

(ii) Write a balanced equation to represent the reduction process. At which electrode does this occur? **1**

Criteria	Mark(s)
$Ag^{+} + e^{-} \rightarrow Ag(s)$ or $Ag(CN)_2^{-} + e^{-} \rightarrow Ag(s) + 2\,CN^{-}$	1

(g) Consider the electrolysis set-up below:



Describe using half-equations what happens at the anode and the cathode during electrolysis given the condition outlined in the table below: **2**

Cell	Electrodes	Electrolyte
1	copper	$CuSO_4$
2	carbon	K_2SO_4

Criteria	Mark(s)
Cell1 Anode (positive electrode): $Cu(s) \rightarrow Cu^{2+} + 2e^{-}$ Cathode (negative electrode) $Cu^{2+} + 2e^{-} \rightarrow Cu(s)$ Cell 2 Anode:(positive electrode) $H_2O \rightarrow 1/2\ O_2(g) + 2\ H^{+} + 2e^{-}$ Cathode: $H_2O + e^{-} \rightarrow 1/2\ H_2(g) + OH^{-}$	1

End of Question 29

END OF TEST [1]