HSC Trial Examination 2005

Chemistry

Solutions and marking guidelines

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Section I

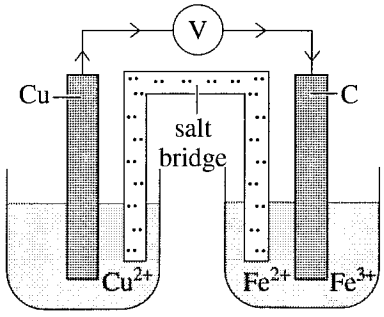
Part A

Answer and explanation	Syllabus content and course outcomes
Question 1 **D** Answer A shows oxidation. Answer B shows an incorrect equation. Answer C shows a change in oxidation state of 1 by reduction. Answer D shows a change in oxidation state of 2 by reduction.	9.2.4 H7, H8
Question 2 **C** Mass of CO_2 is 4 g, so mole of CO_2 is $\frac{4}{44} = \frac{1}{11}$. Volume of CO_2 is $\frac{1}{11} \times 24.79 = 2.25$ L. The other alternatives use molar volume at 0°C (B), 296 g of CO_2 (C) and 14.7 g of CO_2 (D).	9.1, 9.3.2 H10
Question 3 **B** Citric acid is a much weaker acid than hydrochloric acid. Therefore more citric acid molecules are required to produce the same pH as that of a hydrochloric acid solution.	9.3.3 H2, H8, H10
Question 4 **B** Answers A and C have their respective conjugates the wrong way around. Answer D, SO_4^{2-} cannot be amphiprotic.	9.3.4 H13
Question 5 **D** Answers A and B cannot be correct because different indicators change colour with different pH ranges. Answer C is not correct because not all acids and bases react in a 1 : 1 molar ratio.	9.3.1, 9.3.4 H8, H10, H12, H14
Question 6 **B** Zinc is more reactive than copper and so must be the anode. Therefore it is also oxidised. The electrons travel to the copper making it the cathode; however copper cannot be reduced and so its ions must be the species which accept the electrons.	9.2.4 H8, H13, H14
Question 7 **B** Transuranic elements can be produced when the nuclei of smaller atoms are accelerated into the nuclei of very large atoms.	9.2.5 H7
Question 8 **B** The equilibrium system would react to the decrease in temperature by increasing the temperature. This is achieved by favouring the forward reaction, which is exothermic.	9.4.2 H2, H8, H10
Question 9 **B** Esterification is an equilibrium process that results in the formation of an ester and the elimination of a small molecule such as water.	9.3.5 H9
Question 10 **B** Acid/base neutralisation reactions are exothermic.	9.4.7 H7
Question 11 **A** The only correct, positive identification for calcium ions shown in the options is a red flame test.	9.4.3 H8, H11

Part A (Continued)

Answer and explanation	Syllabus content and course outcomes
Question 12 **B** Isomers have the same molecular formulae but different structural formulae. From the options, 2-fluoro-3-methylbutane and 1-fluoropentane both have the same molecular formula of $C_5H_{11}F$ but they have different molecular structures.	9.4.4 H9
Question 13 **B** Filtration is the only physical process presented as an option. All other options involve a chemical change.	9.4.5 H4, H7
Question 14 **C** All other equations are incorrectly balanced for insufficient oxygen.	9.4.1 H9, H10
Question 15 **B** Always add acid to water, as energy is used to ionise the acid rather than being released to the environment, as would happen with A. C and D should both have the acid being diluted with water followed by neutralisation with dilute sodium hydrogen carbonate, to minimise the heat released.	9.1 H8

Part B

Sample answer	Syllabus content, course outcomes and marking guide
Question 16	9.2.3 H13, H14
Water and ethanol are both polar solvents, but ethanol also has a non-polar ethyl group as part of its structure. Consequently it is able to dissolve both non-polar and polar molecules and ionic substances, whereas water will dissolve polar molecules and ionic substances much better than non-polar molecules. The results in the table confirm this – ethanol has dissolved the ionic sodium chloride, and the predominantly non-polar heptanol. Water has dissolved ionic sodium chloride, but has not dissolved the predominantly non-polar heptanol.	• Analyses results in terms of solvent and solute polarity for each solvent and solute. . . . . 3–4 • Describes the results in the table with some explanation. . . . . 2 • States ethanol is a better solvent than water. 1
Question 17	9.2.1, 9.2.3, 9.3.5, 9.4.2 H1, H2, H7, H13
(a) Examples include finely divided iron/iron oxide in the Haber process, in which hydrogen gas and nitrogen gas are converted into ammonia; and zeolites, used in the catalytic cracking of crude oil into fractions containing smaller molecules. Catalysts are not consumed in the reaction.	• Identifies three features of a catalyst . . . . 2 • Identifies two features of a catalyst 1
(b) Catalysts are agents that increase reaction rates by reducing the activation energy of reactions by providing alternative pathways for the reaction. They are usually solids, providing a surface that allows the reacting particles to collide with the correct orientation, resulting in more successful collisions.	• Describes two processes correctly and names the catalyst used in each. . . . . 2 • Describes two processes using the same catalyst and states two features of the catalyst. OR • Describes catalysts in general and names two processes. 1
Question 18	9.2.4 H7, H13
 Anode is $Cu_{(s)}$, cathode is $C_{(s)}$. **Anode reaction:** $Cu(s) \rightarrow Cu^{2+}_{(aq)} + 2e^-$ $E^0 = +0.34$ V **Cathode reaction:** $Fe^{3+}_{(aq)} + e^- \rightarrow Fe^{2+}_{(aq)}$ $E^0 = +0.77$ V **Overall:** $Cu_{(s)} + 2Fe^{3+}_{(aq)} \rightarrow Fe^{2+}_{(aq)} + Cu^{2+}_{(aq)}$ EMF = +0.43 V	• Draws working cell and correctly labels anode and cathode. AND • Shows correct equations and cell voltage. . . . . 5 • Correct cell diagram and labels. AND • Correct voltage but leaves out equations. . . . . 4 • Correct equations and voltage but no diagram or diagram incomplete. . . . . 2–3 • Correctly labelled diagram. . . . . 2 • Some attempt made to draw diagram. . . . 1

Part B (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
Question 19	9.1 H11, H13
Destructive testing changes the nature of the substance being tested, whereas non-destructive testing does not. An example of destructive testing is the use of universal indicator to determine the pH of a solution due to the colour of the indicator in it. A non-destructive method would be to use a pH meter, as it does not change the colour of the solution.	• Gives relevant examples with explanation. AND • Outlines the difference in the types of test. . . . . 2–3 • Gives relevant examples without explanation. OR • Outlines the difference in the types of test. 1
Question 20	9.2.3, 9.3.5 H12, H13
(a) $C_2H_4 + H_2O \rightarrow C_2H_5OH$ at 300°C in the presence of sulfuric or phosphoric acid.	• Writes a balanced equation for the production of ethanol by hydrating ethylene. 1
(b) Acetic (ethanoic) acid.	• Correctly names acetic (ethanoic) acid. . . 1
(c) Condenser used must not be sealed. This prevents the build-up of pressure which could otherwise cause the condenser to explode. The volatile reactants are flammable and so they must not be exposed to a naked flame or spark.	• Identifies two safety techniques and explains why they are needed. . . . . 2 • Identifies one safety technique and explains why it is needed. 1
Question 21	9.2.2 H1, H3, H4, H16
(a) Biopol is a biopolymer extracted from bacteria such as Alcaligenes eutrophus, which digest glucose and valeric acid to produce a combination polymer (or copolymer) of polyhydroxybutanoate and polyhydroxyvalerate. The bacteria are desiccated and dissolved in $CHCl_3$ to produce a plastic which can be moulded by heat.	• Describes making of a **named** biopolymer, including intermediate organisms or specific reagents needed. . . . . 2 • Describes biopolymers in general. 1
(b) Biopol can be moulded into useful shapes such as plastic sheets used in farming or drawn into fibres for use in fishing nets. It is biodegradable so it will break down over time, unlike polymers made from petrochemicals.	• Names a use and explains why it is useful in terms of two properties. . . . . 2 • Describes a property of polymers. 1
(c) Biopol and polyethylene are each thermoplastic (moulded by heat) and are able to be formed into sheets, shapes and fibres. Biopol is more expensive to produce than polyethylene. However, biopol is biodegradable in anaerobic conditions, whereas polyethylene is not.	• Compares the polymers giving two or more uses and two differences, including biodegradability and either cost or method of production. . . . . 3–4 • Some comparison is made. 1–2
Question 22	9.3.4, 9.4.4 H2, H6, H13
O_3 and NH_4^+ show coordinate bonding, in which both electrons needed to form a covalent bond are donated by one of the atoms involved. In the case of NH_4^+, each ion is formed when a lone pair of electrons from the nitrogen is donated to a H^+, which has no electrons of its own to share. In O_3, a lone pair from an O_2 molecule is donated to an O atom. In H_2O the bonds are 'normal' covalent bonds, formed by oxygen and hydrogen each donating an electron to form a single covalent bond.	• Chooses O_3 and NH_4^+ and justifies the choice by correctly applying the concept of coordinate bonding. . . . . 3 • Chooses one species and correctly justifies the choice. . . . . 2 • Chooses one species correctly. OR • Defines coordinate bonding. 1

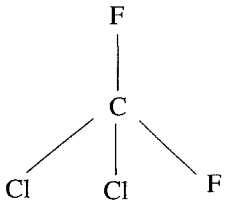
Part B (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
Question 23	9.3.2 H4, H8, H13
As the concentration of CO_2 in the atmosphere rises, more of it will dissolve in the oceans. This is a consequence of Le Chatelier's Principle, which states that when an equilibrium is disturbed the reaction will shift to minimise the change. In this case the first equilibrium system affected is: $CO_{2(g)} \rightleftharpoons CO_{2(aq)}$ Then, $CO_{2(aq)} + H_2O_{(l)} \rightleftharpoons H^+_{(aq)} + HCO_3^-{}_{(aq)}$ The increase in concentration of H^+ means the acidity has increased.	• Relates increase in atmospheric CO_2 to increases in dissolved CO_2 and reaction with water to produce $H^+_{(aq)}$, through application of Le Chatelier's Principle. . . . . 3–4 • Describes increases in acidity due to more dissolving of CO_2 or increased production of $H^+_{(aq)}$. . . . . 2 • Describes Le Chatelier's Principle using CO_2 in some way. 1
Question 24	9.3.1, 9.3.4 H10, H11, H12, H14
(a) Phenolphthalein changes colour (from colourless to pink) as the pH changes from 8 to 10. Vinegar contains the weak acid, acetic acid, which produces the relatively strong CH_3COO^- as its conjugate base. CH_3COO^- reacts with water to produce OH^- ions in solution, hence the final solution is alkaline at the equivalence point.	• Justifies the use of phenolphthalein to identify equivalence point in weak acid/strong base titration. . . . . 2 • States weak acid/strong base titration needs phenolphthalein. 1
(b) Average volume of NaOH used is 23.00 mL (ignore the rough titration as it is too far away from the other values). $NaOH + CH_3COOH \rightarrow NaCH_3COO + H_2O$ mol CH_3COOH = mol NaOH for diluted sample $cV(CH_3COOH) = cV(NaOH)$ $c \times 0.0200 = 0.22 \times 0.0230$ (average volume) $c = 0.22 \times 0.023 / 0.020 = 0.253$ mol L^{-1} Therefore $C_{\text{undiluted sample}} = 2.5$ mol^{-1}, as it has been diluted from 50.00 mL to 500.0 mL.	• Shows relevant steps in the calculation including a chemical equation. AND • Leaving out the rough run. AND • Allows for dilution factor and has correct units. . . . . 3 • Calculates concentration of diluted sample showing relevant steps. . . . . 2 • Some correct effort made, e.g. correct mole ratio; average volume of NaOH determined; dilution factor allowed for. 1
(c) Follow the same procedure as the method given but instead of using an indicator follow the reaction by measuring the change in pH using a data logger. The curve produced can be used to determine the equivalence point of the titration.	• Describes an alternative method that is valid. . . . . 2 • Names a method. 1
Question 25	9.4.2 H1, H6, H4, H13
(a) $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$	• Writes a balanced chemical equation showing correct molecular formula for each species as well as states. 1
(b) Most of the ammonia produced is used in the manufacture of fertilisers; however, other important uses include metal extraction, production of cleaning agents and the manufacture of explosives.	• Identifies and/or describes one correct industrial use of ammonia. 1

Part B (Continued)

	Sample answer	Syllabus content, course outcomes and marking guide
(c)	In 1912, Europe was on the brink of World War I. Since ammonia was used in the manufacture of explosives and nitrogen-based fertilisers, demand was far greater than actual supply. At the time most of the Germany's supply came from nitrate deposits in Chile. At the time of WWI the allied forces had blocked the supply route and Germany needed a new source. The Haber synthesis of ammonia facilitated the manufacture of fertilisers for continued food production and provided for the continued manufacture of explosives. Haber's contribution overcame supply problems for Germany's war effort and is held by many to be responsible for prolonging the war. For these reasons, the development of the Haber process at this time in world history had great significance.	• Identifies and gives a the significance of the Haber process for Germany's war effort in terms of fertilisers and food production and the manufacture of explosives. AND • Includes an evaluation statement. . . . . 4 • Identifies and describes the significance of the Haber process for Germany's war effort in terms of fertilisers and food production or the manufacture of explosives only. AND • Includes an evaluation statement. . . . . 3 • Identifies and describes the significance of the Haber process for Germany's war effort in terms of fertilisers and food production. OR • The manufacture of explosives only. . . . . 2 • Makes a statement about the significance of the process to the German war effort. OR • Makes a statement about increased food production as a result of fertilisers. OR • The manufacture of explosives in terms of the benefits to society. 1
Question 26		9.4.3 H12, H14
(a)	The student should use nitric acid. If sulfuric acid was used, this would provide the solution with sulfate ions. When the solution was later tested for the presence of sulfate ions, the student could not then confirm that their presence was from the mineral.	• States nitric acid is used and provides an appropriate explanation. . . . . 2 • States nitric acid is used. 1
(b)	**Lead:** Adds chloride solution; produces a white precipitate. **Copper:** Flame test; sprayed into flame to produce a blue-green flame. **Sulfate:** Add barium nitrate solution; white precipitate is produced.	• Provides an appropriate test and expected result for each ion. . . . . 3 • Provides an appropriate test and expected result for two ions. . . . . 2 • Provides an appropriate test and expected result for one ion. 1

Part B (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
Question 27	9.4.4 H4, H8, H9, H14, H16
(a) freon-12 (dichloro-difluoromethane)  	• States common name, correct IUPAC name, correct chemical formula or draws correct structural formula for an alkane that has had all of its hydrogen atoms replaced by chlorine or fluorine atoms. 1
(b) In the stratosphere short wavelength UV radiation decomposes O_2 to form O radicals, which can then combine with O_2 to form O_3. Longer UV wavelengths decompose O_3. There is a delicate balance between O_3 formulation and decomposition. However, the decomposition can be catalysed by the presence of chlorine free radicals that can upset the balance. CFCs are unreactive in the lower atmosphere but when they reach the stratosphere they are decomposed by UV light and release chlorine free radicals as shown in the equation below: $CCl_2F_2 + UV \rightarrow CCClF_2 + Cl^{\bullet}$ This chlorine free radical catalyses the decomposition of ozone as follows: $Cl^{\bullet} + O_3 \rightarrow ClO^{\bullet} + O_2$ $ClO^{\bullet} + O \rightarrow Cl^{\bullet} + O_2$ The net equation can be shown as: $O_3 + O^{\bullet} \rightarrow 2O_2$ The same chlorine free radical atom can then go on to decompose many more ozone molecules.	• Identifies that the natural equilibrium between atmospheric oxygen and ozone can be upset by the chlorine free radical which comes from CFCs. AND • Writes a comprehensive series of chemical equations to show the decomposition of ozone. AND • Explains that the chlorine free radical acts in the same way as a catalyst. . . . . 4 • Writes a comprehensive series of chemical reactions showing the decomposition of ozone. AND • Explains that the chlorine free radical acts in the same way as a catalyst with no mention of the natural balance between ozone and oxygen. . . . . 3 • Write some correct chemical equations for the decomposition of ozone and explains the natural balance between ozone and oxygen. OR • Write some correct chemical equations for the decomposition of ozone and explains that the chlorine free radical acts like a catalyst. OR • Writes a comprehensive series of chemical equations with no explanation. . . . . 2 • Writes a relevant and correct chemical equation. OR • Mentions the balance between atmospheric oxygen and ozone. OR • Mentions that the chlorine free radical acts like a catalyst. 1

Part B (Continued)

	Sample answer	Syllabus content, course outcomes and marking guide
(c)	International concerns regarding ozone depletion have led governments around the world to phase out the use of CFCs. A series of international agreements, starting with the Montreal Protocol in 1987, brought forward a phasing out of CFCs in industrialised countries in 1995. Alternative compounds have replaced CFCs. Initially, hydrochlorofluorocarbons were used, but these have been replaced by hydrofluorocarbons that do not contain chlorine. These compounds are widely used in refrigeration and air conditioning.	• States that governments around the world are phasing out the use of CFCs with the signing of international treaties. AND • Identifies and describes an alternative to the use of CFCs.. . . . . 2 • States that governments around the world are phasing out the use of CFCs with the signing of international treaties. OR • Identifies and describes an alternative to the use of CFCs.. 1

Section II

Question 28 Industrial Chemistry

		Sample answer	Syllabus content, course outcomes and marking guide
(a)	(i)	Rubber which is the sap collected from the bark of rubber trees.	9.5.1 H3, H4 • Correctly identifies a dwindling natural resource. 1
	(ii)	Styrene-butadiene rubber is a polymer made from styrene and butadiene monomers.	• Correctly identifies a replacement material. AND • Describes one feature of the structure of the replacement material. . . . . 2 • Correctly identifies a replacement material. 1
(b)	(i)	$K = \frac{[CO] \times [H_2]}{[H_2O]}$	9.5.2 H8, H10, H13 • Writes a correct expression for the equilibrium constant. 1
	(ii)	If the pressure in the system was decreased, Le Chatelier's Principle states that the system will adjust itself to minimise the disturbance. This system will adjust by increasing the pressure. Because there are more gaseous molecules on the product side of the equation, the pressure will be increased by favouring the products, which will also increase the yield.	• Correctly identifies a change to the system that could increase the yield of the products. AND • Explains how this change affects the equilibrium in terms of Le Chatelier's principle. . . . . 3 • Correctly identifies a change to the system that could increase the yield of the products. AND • Gives a partial explanation of how this change affects the system. . . . . 2 • Correctly identifies a change to the system that could increase the yield of the products. 1
	(iii)	The equilibrium concentration of hydrogen would be the same as the equilibrium concentration of carbon monoxide, which is 0.200 mol L^{-1}.	• Correctly determines the equilibrium concentration of hydrogen. 1
	(iv)	$K = \frac{[CO] \times [H_2]}{[H_2O]}$ $= \frac{0.200 \times 0.200}{0.050}$ $= 0.8$	• Correctly calculates the value for K using the expression written in (i). 1
	(v)	Increasing the temperature in the system would decrease the value of the equilibrium constant.	• Correctly describes how the equilibrium constant would change when the temperature was increased. 1

Question 28 Industrial Chemistry (Continued)		Sample answer	Syllabus content, course outcomes and marking guide
(c)	(i)	Before performing the dilution eye protection, gloves and protective clothing should be put on. To dilute the acid, the concentrated acid must be slowly added to the water with continuous stirring. The ionisation of sulfuric acid is an exothermic process that releases heat energy. If water is added to the concentrated acid, the heat released can cause the water to boil, releasing steam and causing the acid to spit violently. This is highly dangerous and poses a significant safety hazard.	9.5.3 H7, H8, H12 • Outlines a procedure which indicates the need for wearing protective clothing or glasses. AND • States that sulfuric acid must be added to the water. AND • Explains the safety precautions by stating that the ionisation of sulfuric acid is exothermic. AND • Describes the effects and consequences of adding water to the acid . . . . . 4 • Any three of the above. . . . . 3 • Any two of the above. . . . . 2 • Any one of the above. 1
	(ii)	Oxidising agent: $Cu + 2H_2SO_4 \rightarrow CuSO_4 + 2H_2O + SO_2$ Dehydrating agent: $C_{12}H_{22}O_{11} + H_2SO_4 \rightarrow 12C + 11H_2O$	• Writes two correctly balanced chemical equations showing sulfuric acid acting as a dehydrating agent and an oxidising agent. . . . . 2 • Writes one correctly balanced chemical equation showing sulfuric acid acting as either a dehydrating agent or an oxidising agent. 1
(d)	(i)	Anionic.	9.5.5 H4, H6, H14 • Correctly identifies the detergent as anionic. 1
	(ii)	The long hydrocarbon chain on the detergent is non-polar while the anionic head of the detergent is polar. During cleaning, the non-polar tail will be attracted to fats, greases and oils that are also non-polar. The detergent molecules will surround the lipid with their polar and hydrophilic heads facing outwards and their non-polar hydrophobic tails facing inwards. The heads are attracted to water molecules and the fat gets carried away from the surface of the object being cleaned with the water.	• Gives a comprehensive description of the cleaning action of a detergent which includes: the identification of the polar and non-polar properties of the detergent, the attraction and orientation of the detergent molecule to the lipid being removed and the hydrophilic attraction to the water. . . . . 3 • Gives an adequate description of the cleaning action of detergents but without reference to the polar and non-polar properties of the detergent. . . . . 2 • Makes a correct statement about the cleaning action of detergents. 1

Question 28 Industrial Chemistry (Continued)		Sample answer	Syllabus content, course outcomes and marking guide
	(iii)	China and glass will usually acquire a net negative charge. The ammonium salt is cationic which means the positively charged head of the detergent will be attracted to the surface of the china or glass. This will render it ineffective as a cleaning agent. The anionic detergent will be repelled by the negatively charged china or glass and it can thus do its job of removing the fats and oils from the object being cleaned.	• Identifies that the anionic detergent is the better choice. AND • Gives an explanation of why based on the fact that the surface of china and glass usually acquires a negative charge, creating an attraction between the surface and the detergent. . . . . 2 • Identifies that the anionic detergent is the better choice but without any explanation. 1
(e)	(i)	$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$	9.5.5 H8, H11 • Write a correct chemical equation for one of the steps in the Solvay process. 1
	(ii)	Some calcium carbonate was placed in a side arm test-tube and heated using a Bunsen burner. The gas produced was bubbled through limewater to verify that it was carbon dioxide.	• Provides a comprehensive outline of an appropriate method . . . . . 2 • Provides an appropriate method but lacks some of the detail required. 1

Question 29 Shipwrecks, Corrosion and Conservation

		Sample answer	Syllabus content, course outcomes and marking guide
(a)	(i)	Passivity occurs when the oxide layer formed is impermeable. This prevents reactants diffusing through the layer and so no further corrosion of the metal can occur.	9.6.2 H13, H14 • Provides an explanation which states that passivity refers to the formation of an impermeable oxide layer that prevents reactants diffusing to the metal below and so prevents further corrosion. 1
	(ii)	The oxide layer in iron does not provide passivity. The graph shows that the corrosion rate of iron is greater than zero. The graph shows that corrosion occurs at all pH levels. Therefore, if a student interprets no corrosion, they are wrong.	• Identifies that the oxide layer does not provide passivity with reference to the graph. . . . . 2 • Identifies that the oxide layer does not provide passivity without reference to the graph. 1
	(iii)	The graph shows that the corrosion rate of iron increases as the pH of the water lowers. This trend is observed from a pH of 3. This is because the oxide layer formed is more soluble in acidic conditions. The removal of this layer then allows the exposed iron to react with the acid. These reactions can be seen in the following equations: $FeO + 2H^+ \rightarrow Fe^{2+} + H_2O$ $Fe + 2H^+ \rightarrow Fe^{2+} + H_2$	• Identifies rate of corrosion increases as pH lowers from a pH of 3. AND • States that FeO is more soluble at low pH's and hence is removed. AND • States that Fe is consequently exposed and so reacts with acid and includes both relevant equations. . . . . 4 • Identifies rate of corrosion is greater at lower pH values and includes relevant equations OR • Gives appropriate reasons. . . . . 2–3 • Identifies rate of corrosion is greater at lower pH. 1
(b)	(i)	• Take a strip of iron and cut into three pieces of the same size. • Dip one piece of the iron in clear lacquer and allow it to fully dry. Make sure the lacquer has completely coated the iron. • Cover one piece of iron with petroleum jelly. Make sure that the iron is completely coated with the jelly. • Place three test tubes in a test tube rack. • In each test tube pour 10 mL 2 M NaCl solution. • In the first test tube, place the piece of uncoated iron. In the second test tube, place the lacquer coated iron. In the third test tube, place the petroleum jelly coated iron. • Make sure each piece of iron is fully covered by the salt solution. • Leave the pieces in the solution for two days; note any change in their appearance.	9.6.4 H11, H12 • Clearly outlines the procedure used for two different coatings, including the use of a control. . . . . 3 • Partly outlines the procedure used for two different coatings or clearly outlines one type of coating used to protect a metal from corrosion. 1–2

Question 29 Shipwrecks, Corrosion and Conservation (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
(ii) • The piece of iron used was the same type in each case. • Each piece of iron was placed in the same amount of the same solution. • Each piece of iron was fully covered by the solution.	• Identifies three different controlled variables. . . . . 2 • Identifies one or two different controlled variables. 1
(iii) The piece of iron used as the control, i.e. the piece not coated, showed obvious rusting. This is because there was no barrier preventing oxygen and water reacting with the iron. The other two pieces of iron showed no evidence of rusting. The coating in each case produced an impermeable barrier which prevented any oxygen and water coming into contact with the iron and so no rusting could occur. Both the lacquer and petroleum jelly were effective in preventing the corrosion of the iron because oxygen and water were unable to come into contact with the iron to produce rust.	• Identifies the relationship of oxygen and water in the process of rusting; identifies that coatings create a barrier preventing oxygen and water making contact with the iron; compares results to the uncoated iron; makes a judgement of the effectiveness of the coatings. . . . . 4 • Identifies the relationship of oxygen and water in the process of rusting; identifies that coatings create a barrier preventing oxygen and water making contact with the iron; makes a judgement of the effectiveness of the coatings. . . . . 2–3 • Identifies that coatings create a barrier preventing oxygen and water making contact with the iron. 1
(c) The Australian ship *Vernon* was completed in 1839 and was moored in Sydney Harbour from 1871 to 1891. The anchors from this ship are currently on display outside of the Australian National Maritime Museum. The corrosion on the cast iron anchors was blasted away with copper slag and then garnet polished. The timber stocks that were attached to the anchors needed to be covered during this process to prevent them from being damaged. The iron was then protected with a zinc epoxy paint. The zinc acts anodically compared to the iron. Since it is also passivating, it creates an impermeable layer preventing further corrosion. The timber stocks were saturated with a zinc napthenate solution. This is a fungus and mould growth retarding agent which does not discolour the timber. This technique used to restore the iron is not as effective as electrolysis. However, it was chosen instead of electrolysis for two reasons: 1. removal of the timber stocks would have been necessary – this may have caused irreparable damage to the timber; and 2. the anchors were considered to be in a condition that was already good enough and so did not require the more drastic measure of electrolysis.	9.6.7 H11, H12 • Names the Australian maritime project. • Describes the procedures used and explains how they restore the artefact. AND • Compares one procedure to an alternate procedure. AND • Justifies the use of this procedure in comparison to the alternate one. . . . . 5 • Describes and partially explains the procedures used and how they restore the artefact. AND • Compares one procedure to an alternate procedure. AND • Justifies the use of this procedure in comparison to the alternate one. . . . . 4 • Describes and partially explains the procedures used and compares these procedures to an alternate procedure. OR • Justifies the use of a procedure in comparison to the alternate one. . . . . 2–3 • Describes the procedures used. 1

Question 29 Shipwrecks, Corrosion and Conservation (Continued)

		Sample answer	Syllabus content, course outcomes and marking guide
(d)	(i)	An electrolyte is a substance that, in solution (or molten), conducts electricity.	9.6.3 H13, H14 • Provides an adequate definition for the word *electrolyte*. 1
	(ii)	According to the diagram, Na^+ is reduced and Cl^- is oxidised. $Na^+ + e^- \rightarrow Na$ $E = -2.71$ V $Cl^- \rightarrow \frac{1}{2}Cl_2 + e^-$ $E = -1.36$ V Total $E = -4.07$ V Since overall voltage is negative, an input of more than 4.07 V is required for this cell reaction to proceed; thus, a battery is needed.	• Provides appropriate half equations to show that overall voltage is negative; relates negative voltage to requirement of battery to make total voltage in circuit positive. . . . 2 • Provides appropriate half equations to show that overall voltage is negative or relates negative voltage to requirement of battery to make total voltage in circuit positive. . . . 1
	(iii)	Both sodium and chlorine react in water and so cannot be formed in water. Therefore, there must be no water present in the electrolyte if these elements are to be produced by electrolysis.	• Identifies that both elements readily react in water and so their formation in water is not possible. OR • Correctly uses E° value to show that H_2O electrolyses in preference to the molten sodium chloride.. 1

Question 30 The Biochemistry of Movement

Sample answer	Syllabus content, course outcomes and marking guide
(a) The general formula for a fatty acid is $CH_3(CH_2)_nCOOH$. The part of the molecule that should mix with water is the = O – OH, because it contains H bonded to O and can therefore form hydrogen bonds with water.	9.73 H9 • Correct general formula. AND • Indication of the hydrophilic end. AND • Explanation of the formation of hydrogen bonds with water . . . . . 3 • Correct general formula. AND • Indication of the hydrophilic end. OR • Explanation of the formation of hydrogen bonds with water . . . . . 2 • Correct general formula. OR • Incorrect general formula with correct indication of the hydrophilic end. OR • Explanation of the formation of hydrogen bonds with water 1
(b) The stage of respiration that uses NADH and $FADH_2$ is oxidative phosphorylation. During this stage these carriers of high energy electrons are oxidised to NAD^+ and FAD. The electrons they release are picked by the cytochrome chain, a series of enzymes in the inner membrane of the mitochondria, and the energy is used to pump the hydrogen ions released into the space between the matrix membrane and the wall of the mitochondria. When the electrons flow back into the space between the two membranes ATP is produced by the phosphorylation of ADP. $NADH + H^+ \rightarrow 2H^+ + 2e^-$ (oxidation of the electron barrier). The electrons are picked up by the cytochrome chain (which is reduced) and the H^+ ions are pumped out of the matrix into the inter-membrane space. Further along the cytochrome chain the hydrogen ions flow back through the membrane producing ATP from ADP + $P_{(i)}$. Finally the electrons are picked up by the highly electronegative oxygen molecule to produce water. $2H^+ + \frac{1}{2}O_2 + 2e^- \rightarrow H_2O$ The equations that summarise the process are: $NADH + H^+ + 3\ ADP + 3\ P_{(i)} + \frac{1}{2}O_2 \rightarrow NAD^+ + 3\ ATP + H_2O$ $FADH_2 + 2\ ADP + 2\ P_{(i)} + \frac{1}{2}O_2 \rightarrow FAD + 2\ ATP + H_2O$	9.79 H7 • Correct identification of the stages that use NADH and $FADH_2$. AND • Detailed description of how these compounds produce ATP. AND • Equations to represent the oxidation of NADH and $FADH_2$ . . . . . 3–4 • Correct identification of the stages that use NADH and $FADH_2$. AND • Description of how these compounds are used to produce ATP. OR • Equations to represent the oxidation of NADH and $FADH_2$ . . . . . 2 • Correct identification of the stages that use NADH and $FADH_2$. OR • Description of how these compounds are used to produce ATP. OR • Equations to represent the overall reaction.1
(c) (i) Pyruvic acid and fatty acids are both converted to acetyl CoA before entering the Tricarboxylic Acid Cycle (TCA cycle).	9.77, 9.78 H8, H9 • Correct identification of the product formed 1

Question 30 The Biochemistry of Movement (Continued)		Sample answer	Syllabus content, course outcomes and marking guide
	(ii)	Depending on the availability of fuels to the muscle cell, fatty acids can be used for energy production especially by type 1 skeletal muscle cells. The breakdown of fatty acids to produce energy results in an increase in the compound acetyl CoA. With the build-up of acetyl CoA, pyruvic acid is no longer converted to acetyl CoA in glycolysis. Conversion of pyruvic acid to acetyl CoA stops until the acetyl CoA is used.	• Demonstrated understanding of the inhibition of the conversion of pyruvate to acetyl CoA in glycolysis when high concentrations of acetyl CoA are present from the oxidation of fatty acids ..... 3 • Identification of the relationship between high levels of acetyl CoA from fats and inhibition of glycolysis 1–2
(d)	(i)	The digestive, protease enzyme chymotrypsin hydrolyses certain peptide bonds in proteins in our diet. As part of its active site, this enzyme has a deep channel which binds the bulky hydrophobic side chains of the substrate protein. This brings the peptide bonds near hydrophobic side chains into a position where they are cleaved. This explains why chymotrypsin breaks specific peptide bonds, which are next to the hydrophobic side chains.	9.74 H9, H11, H13, H14 • Correctly named example and demonstrated understanding of the chemical features of the protein related to the shape including formation of the binding and active sites ..... 3 • Correctly named example and demonstrated understanding of the chemical features of the protein and the formation of a binding or active site ..... 2 • Correctly named example 1
	(ii)	Using models to demonstrate the relationship between enzyme structure and function is valid because it can be inferred from the model that: • The binding site is created by the primary, secondary and tertiary structure of the protein. • The substrate must be able to fit the active site in order to undergo a reaction. Therefore the enzyme is substrate specific. • Binding of the substrate to the binding site uses intermolecular forces to hold the substrate in place. • While the reaction occurs the enzyme remains unchanged. Therefore one enzyme molecule can transform many substrate molecules.	• The formation of structure by secondary and tertiary folding related to side chain groups and the function of a protein. AND • Demonstrated understanding of the use of the model described to develop understanding of the relationship between structure and function of proteins .... 3–4 • Demonstrated understanding of the use of a model to develop understanding of the action of proteins 0–2

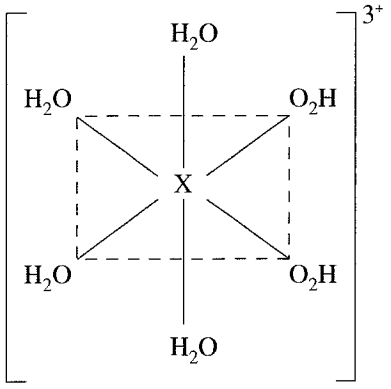
Question 30 The Biochemistry of Movement (Continued)

Sample answer	Syllabus content, course outcomes and marking guide
(e) From one glucose molecule: • Glycolysis produces 2 ATP and 2 NADH. • The Tricarboxylic Acid Cycle produces 2ATP and 6 NADH and 2 $FADH_2$. • Oxidative phosphorylation produces 34 ATP from the NADH and $FADH_2$ making a total of 38 ATP from aerobic respiration. • Anaerobic respiration produces only two molecules of ATP per molecule of glucose. Skeletal muscle consists of actin and myosin fibres. Myosin is a protein that hydrolyses ATP to ADP and $P_{(i)}$. The chemical energy of ATP is released as mechanical energy to move the actin along towards the Z line, or centre, and contract the muscle. While the supply of oxygen is adequate, ATP is freely available for muscle contraction. Type 1 muscle fibres have a good blood supply and can carry out aerobic respiration better than type 2 muscle fibres. They have a greater capacity to produce ATP but cannot do so quickly. If the muscles are contracting rapidly, the supply of oxygen cannot keep up with demand for ATP and anaerobic respiration will occur. The muscle cells will continue to carry out glycolysis and convert glucose to pyruvic acid and 2 ATP as long as the pyruvic acid is converted to lactic acid and removed in the blood to maintain pH levels. Anaerobic respiration is very fast but releases only two molecules of ATP. Aerobic respiration and type 1 muscle fibres are suited to light endurance exercise, such as long distance running, because oxygen is available and ATP can be produced for a long period. Type 2 muscle fibres can produce ATP anaerobically to rapidly contracting muscles. The ATP is produced quickly so these muscle fibres are suited to short, intense bursts of exercise such as sprinting.	9.75, 9.7.10 H4, H7, H13 • Correct comparison of energy outputs in terms of ATP and NADH and $FADH_2$ for both reactions. AND • Outline of the role of ATP in causing muscle contraction. AND • Description of the relationship between blood supply and ATP production by aerobic or anaerobic respiration in two types of muscles. AND • Understanding of the limitations of anaerobic respiration. AND • Evaluation of the importance of both processes to two types of exercise . . . . 6–7 • Correct comparison of energy outputs in terms of ATP and NADH and $FADH_2$ for both reactions. AND • Evaluation of the importance of both processes to two types of exercise. AND TWO OF • Outline of the role of ATP in causing muscle contraction. OR • Description of the relationship between blood supply and ATP production by aerobic or anaerobic respiration in two types of muscles. OR • Understanding of the limitations of anaerobic respiration . . . . . 4–5 • Correct comparison of energy outputs in terms of ATP and NADH and $FADH_2$ for both reactions. AND ONE OR MORE OF • Outline of the role of ATP in causing muscle contraction. OR • Description of the relationship between blood supply and ATP production by aerobic or anaerobic respiration in two types of muscles. OR • Understanding of the limitations of anaerobic respiration 2–3

Question 30 The Biochemistry of Movement (Continued) Sample answer	Syllabus content, course outcomes and marking guide
(e) (continued)	• Correct comparison of energy outputs in terms of ATP and NADH and $FADH_2$ for both reactions. OR • Outline of the role of ATP in causing muscle contraction. OR • Description of the relationship between blood supply and ATP production by aerobic or anaerobic respiration in muscles. OR • Understanding of the limitations of anaerobic respiration 1

Question 31 The Chemistry of Art

Sample answer	Syllabus content, course outcomes and marking guide
(a) (i) Early Aboriginals used pigments based on clays containing iron oxide, or zinc oxide or charcoal. Clay materials produced ochres of various hues. The colours were white from zinc oxide, variations of brown from iron oxides and black from charcoal.	9.8.1 H1, H12.3, H12.4, H13 • States the names of two or more pigments. AND • Their sources.. . . . . 2 • States the names of two or more pigments. OR • Their sources.. 1
(ii) They did not have the technology to extract blue or purple from copper ores or from other sources such as plants. The early Aboriginals used pigments that occurred in their natural state.	• Explains role of technology or availability of pigment in enabling its use 1
(b) A transition metal with variable oxidation states is iron. The element has an electron structure: $1s^2 2s^2 2p^6 3s^3 3p^6 4s^2 3d^6$. When iron reacts it can form the ion Fe^{+2} by losing the $4s^2$ electrons, with configuration $1s^2 2s^2 2p^6 3s^3 3p^6 3d^6$, with three pairs of electron in the d orbitals aligned axially, or Fe^{+3} which forms when two 4s electrons and one 3d electron are lost, with configuration $1s^2 2s^2 2p^6 3s^3 3p^6 3d^5$, with one electron in each d orbital.	9.8.2–9.8.4 H12.4, H13 • Correctly identifies at least two oxidation states of another transition element. AND • Uses changes in electron configuration to illustrate the different oxidation states of the named element (at least two specific electron configurations are given for particular ions/states). AND • Specifically highlights the fact that in transition metals, electrons can be lost from the s and/or d orbital in achieving different oxidation states/ions. . . . . 3 • Correctly identifies at least two oxidation states of another transition element. AND • Uses changes in electron configuration to illustrate the different oxidation states of the named element (at least one specific electron configurations is given for particular ions/oxidation states). OR • Specifically highlights the fact that in transition metals, electrons can be lost from the s and/or d orbital in achieving different oxidation states/ions. . . . . 2 • Correctly identifies at least two oxidation states of another transition element. 1

Question 31 The Chemistry of Art (Continued) Sample answer	Syllabus content, course outcomes and marking guide
(c) (i) Ammonia, NH_3, is a ligand as it is able to donate a non-bonding pair of electrons to a central metal cation, forming a coordinate covalent bond.	9.9.5 H6, H13 • Correctly identifies a ligand from the list. AND • Explains that it is a ligand due to presence of a non-bonding pair of electrons (that can form coordinate covalent bond with a metal ion) . . . . . 2 • Correctly identifies ligand from the list. OR • Explains that a ligand is a species that contains a non-bonding pair of electrons (that can form a coordinate covalent bond with a metal ion) 1
(ii) 	• Correctly draws an octahedral complex ion with O of H_2O facing X. . . . . 2 • Correct diagram but incorrect charge or O not facing X. 1

Question 31 The Chemistry of Art (Continued) Sample answer	Syllabus content, course outcomes and marking guide
(d) Electronegativity is the ability of an atom involved in a bond to attract the electron pair in the bond. For the main group elements in period 4, K to Br, the electronegativity generally increases from left to right. As the number of outer shell electrons in an atom increases so does the nuclear charge, resulting in an increased ability to attract electrons in a covalent bond. For the transition elements, titanium to copper, the outer shell is 4s for each of them. This shell is shielded by the gradually filling inner 3d shell and consequently there is little change in the electronegativities of the transition elements.	9.8.3 H6, H12, H13 • Correctly defines electronegativity. AND • Correctly states the trend of increasing electronegativity across a period or with increasing number of valence electrons. AND • Relates move across period/increasing number of valence electrons within a period to increasing nuclear charge. AND • Clearly explains that the increase in electronegativity is due to an increasing attractive force between nucleus and valence electrons occupying the same outer shell. AND • Uses Period 4 examples to highlight trends for main group and transition elements. . 4 • Correctly defines electronegativity. AND • Correctly states the trend of increasing electronegativity across a period or with increasing number of valence electrons. AND • Relates move across period/increasing number of valence electrons to increasing nuclear charge or more protons in the nucleus. • AND • Uses Period 4 examples to highlight trends for main group or transition elements.... 3 • Correctly defines electronegativity. AND • Correctly states the trend in electronegativity across a period or with increasing number of valence electrons (little or no adequate explanation given). Examples may be given but explanation is not adequate. ..... 2 • Correctly defines electronegativity. OR • Correctly states the trend in electronegativity across a period/ with increasing number of valence electrons.. 1

Question 31 The Chemistry of Art (Continued)		Sample answer	Syllabus content, course outcomes and marking guide
(e)	(i)	Vanadium has a range of oxidation states from +5 to +2. V^{+5} is a strong oxidant (as yellow VO_2^+) and it can be reduced by aqueous SO_2 to V^{+4} (as blue VO^{+2}). VO^{+2} can then be reduced by Zn in HCl to green V^{+3} and violet V^{+2}. In our experiment we added acidified 0.1 M $KMnO_4$ dropwise using a dropping pipette into a test tube containing 10 mL of 0.1 M $VCl_{2(aq)}$ in 4 M HCl. The test tube was shaken to unsure mixing.	9.8.4, 9.8.4 H6, H9, H11, H12, H13 • Clearly describes a suitable experiment that correctly demonstrates the oxidising strength/properties of $KMnO_4$. AND • Includes equipment, quantities/ concentrations of solutions used..... 2 • Loosely describes a suitable experiment with clarity or omission of details such as the equipment or solutions used..... 1
	(ii)	A range of colour changes were observed, from violet to green to blue-green and finally yellow. The purple MnO_4^- decolourised until no more oxidation occurred. At this point the yellow solution became pinkish. The observations are explained by the change in oxidation numbers of vanadium from V^{+2} (violet) to V^{+5} in VO_2^+, which is yellow. The $KMnO_4$ is a stronger oxidant than VO^{+2} since it was able to oxidise lower oxidation states of vanadium to V^{+5}.	• Clearly and correctly describes or tabulates the colour changes observed for two or more changes in oxidation state of species in the experiment. AND • Explains observed colour changes by referring to altered oxidation states of specific species. AND • Explains that $KMnO_4$ is a strong oxidant and relates ease of its reduction to its oxidising ability..... 3 • Outlines at least two colour changes from the practical. AND • Makes reference to the species involved but with no clear link between colours and species. AND • States that $KMnO_4$ is a strong oxidant with vague reasoning..... 2 • Briefly outlines colour changes from the practical. OR • States that $KMnO_4$ is a strong oxidant with vague or no reasoning..... 1

Question 31 The Chemistry of Art (Continued) Sample answer	Syllabus content, course outcomes and marking guide
(f) A number of pigments are based on copper, including azurite $Cu_3(CO_3)_2(OH)_2$ and turquoise $CuAl_6(PO_4)_4(OH)_8.4H_2O$ as well as verdigris. Ultraviolet and infrared light can be used to help identify the pigments present in an art work and provide information about their composition, as well as provide information about the binder used in the painting. An absorption spectrum can be prepared by passing UV or IR light through a dissolved sample of the pigment and recording the percentage of light absorbed. The absorbance and the width of the bands in the spectrum provide information about the composition of the pigment and binder and the quantity of various components. These can be matched to known samples to allow determination of the provenance of the painting. Complementary to the absorption spectrum is the reflectance spectrum, in which light is shone on to the solid surface and light which is not absorbed is reflected – the reflected light can be interpreted to determine what was absorbed. Reflectance spectra are useful when it is not possible to dissolve the pigment. UV light cannot penetrate the surface of a painting very deeply (approximately 50 microns) but is still a very valuable tool in identifying pigments. IR light can penetrate more deeply.	9.8.2 H4, H6, H12, H13 • Discusses how two or more parts of the EM spectrum are used. AND • Describes two methods used in identifying composition of copper based pigments. AND • Names at least two named copper based pigments. . . . . 5–6 • Discusses two or more parts of the EM spectrum. OR • Describes a method used to identify pigments. AND • Names at least two copper based pigments. . . . . 3–4 • States that different parts of the EM spectrum can be used to identify copper pigments. AND • Names a copper based pigment. OR • Describes absorption or reflectance spectroscopy. . . . . 2 • Names a copper based pigment or a correct method 1

Question 32 Forensic Chemistry Sample answer			Syllabus content, course outcomes and marking guide
(a)	(i)	High pressure liquid chromatography, gas liquid chromatography or mass spectroscopy.	9.9.5 H3 • Correctly identifies a techniques used to analyse small samples. 1
	(ii)	Amino acids contain an amine ($-NH_2$) group and a carboxylic acid (–COOH) group and have the general formula NH_2–CHR–COOH. They undergo a condensation polymerisation reaction to form polypeptide chains. These chains are called proteins and the amino acids are linked through peptide bonds. These bonds can be broken by enzymes.	9.9.3 H6, H9 • Correctly identifies amino acids functional groups. • Describes proteins as chains of amino acids joined by peptide bonds which can be broken. . . . . 3 • Correctly identifies amino acids functional groups. • Describes proteins as chains of amino acids. . . . . 2 • Correctly identifies the two functional groups in amino acids. 1
(b)	(i)	Copper and mercury.	9.9.6 H14 • Correctly identifies the two elements present in the sample. 2
	(ii)	Atoms can be excited as a result of energy being applied in the form of heat or electricity for example. Atoms emit light when they are excited. This is because excitation causes electrons to be promoted to higher, unstable electron shells. The electrons then relax or return to their lower energy ground state, releasing energy in the process. The energy is released in quanta which correspond to a frequency of light. The frequencies emitted by an atom of a given element are unique because the electron configuration of the atom is unique. Emission spectra consist of a series of lines, each corresponding to a frequency of light emitted by electrons as they relax. Emission spectra are characteristic for elements and are often referred to 'signatures'. Unknown samples and mixtures of elements can be identified by matching the spectral lines of the sample to those of known elements.	9.9.6 H2, H4, H7 • Describes the conditions under which atoms emit light. • Explains the reason why emission spectra are unique. • Discusses the movement of electrons in atoms to produce light. • Identifies how spectra can be used in forensic analysis. . . . . 4 • Identifies that emission spectra are unique. • Describes the conditions under which atoms emit light. • Identifies how spectra can be used in forensic analysis. . . . . 2–3 • Identifies that emission spectra are unique. 1

Question 32 Forensic Chemistry (Continued) Sample answer	Syllabus content, course outcomes and marking guide
(c) Each cell in our body contains DNA which is a high molecular mass polymer. The DNA contains genes which determine unique individual characteristics. Portions of human DNA are unique to each individual. For this reason, analysis of DNA samples can be used to identify individuals. DNA analysis involves 'fingerprinting', a technique used to isolate, amplify and separate the components of DNA. • The DNA sample is collected from hair, skin, saliva, semen, blood, etc. • The DNA is extracted. • PCR, the process of splitting and replicating strands of extracted DNA to increase the amount of sample, is performed. • The DNA is cut into fragments by using an enzyme chosen to act at a particular place in the DNA strand. • Electrophoresis is used to separate the fragments. • The separated fragments are made visible using X-ray film. • The result is a series of bands which can be compared to standard samples for identification. Using DNA to identify individuals requires the collection and analysis of DNA samples from known individuals. These analysed samples need to be kept on file so they can be referred to in forensic investigations. DNA analysis data is maintained in DNA data banks. The maintenance of DNA data banks allows forensics investigators to match samples against individual data to identify paternity or suspects in criminal investigations. DNA samples are provided voluntarily or taken from known offenders. There are concerns about the use of DNA data and the reliability of evidence using DNA data banks. Security, accuracy and access issues are of concern as well the use of DNA information for purposes other than forensic investigation e.g. medical insurance and employment screening. DNA analysis can't be used as the only evidence in criminal proceedings and other evidence is needed. However, DNA analysis is very useful in paternity cases and for supporting other evidence. It can also be used to eliminate suspects and this is an important use in the re-examination of criminal cases. The use of DNA analysis to identify individuals has important and profound implications for criminal justice but must be used carefully, responsibly and in conjunction with other evidence. The use of DNA data banks needs to be properly controlled and access needs to be well documented.	9.9.4 H4, H5, H9, H11, H12 • Completely describes the process for DNA analysis including the PCR. • Discusses the unique nature of an individual's DNA and how this enables identification. • Identifies uses of DNA fingerprinting in forensic chemistry, discussing the limitations. • Discusses the use of DNA databanks, identifying advantages and disadvantages. • Provides well support judgment statement. . . . . 7 • Describes a technique used for DNA analysis, including a description of the PCR. • Discusses the uses of DNA in identifying individuals. • Discusses the use of DNA data banks, providing advantages and disadvantages. • Provides a judgment statement. . . . . 6 • Describes the techniques for analysing DNA, including the PCR. • Discusses the uses of DNA in identifying individuals. • Describes the use of DNA data banks. • Provides a judgment statement. . . . . 4–5 • Identifies a technique for analysing DNA. • Identifies the unique composition of an individual's DNA which allows for identification. • Identifies the concept of DNA data banks. . . . . 2–3 • Identifies a technique for analysing DNA. 1
(d) (i) Carbohydrates are organic compounds containing carbon, hydrogen and oxygen. They have the general formula $C_n(H_2O)_n$.	9.9.2 H6, H9 • Correct definition. 1

Question 32 Forensic Chemistry (Continued)	Sample answer	Syllabus content, course outcomes and marking guide
(ii)	Three test tubes, one containing 5 mL 1% glucose solution, one containing 5 mL 1% sucrose solution, one containing 5 mL water were set up. Add 2 mL of Benedict's solution (a weak oxidising reagent containing an alkaline solution of copper ions) to each test tube and heat in a water bath over a Bunsen burner for five minutes. The test tube containing glucose solution and the test tube containing water stayed a blue colour; the test tube containing sucrose produced a red-brick precipitate.	9.9.2 H9, H11 • Outline of procedure, identifying variables and correctly describing results. . . . . 3 • Outline of procedure, identifying variables and/or controls. . . . . 2 • Outline of procedure. 1
(iii)	Polysaccharides are long chain condensation polymers formed from a monosaccharide such as glucose. The polymerisation reaction of glucose produces a water molecule and either starch, cellulose or glycogen according to the following chemical reaction: $n(C_6H_{12}O_6) \rightarrow (C_6H_{10}O_5)_n + H_2O$ Starch, glycogen and cellulose have different structures and different functions in nature. Starch is stored in the cytoplasm of plants cells and so is only found in plants. Glycogen is stored in the liver and muscle cells of animals and is only found in animals. Cellulose is also found only in plants and is responsible for the fibrous structure of plants.	9.9.2 H6, H9, H14 • Uses a chemical equation to describe the polymerisations of a named monosaccharide, identifying the polysaccharides and whether they are found in animals or plants. . . . . 4 • Names the polymerisation of a monosaccharide, identifying the possible polysaccharides and whether they are present in plants or animals. . . . . 3 • Identifies the polysaccharides present in plants and animals. . . . . 2 • Identifies a polysaccharide. 1