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HSC Trial Examination 2001

Chemistry

Solutions and suggested marking scheme

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Section I

Part A

Answer and explanation	Outcomes assessed
Question 1 D The red colour only indicates that the pH is higher than the range limit of 4.4; it does not identify exactly the pH value.	H14
Question 2 B The monomer needs to be an alkene with a fluorine on each carbon atom. One carbon atom also has a hydrogen atom, the other C atom also has a Cl atom.	H9, H6
Question 3 A Other answers appear if mistakes are made in not allowing for dilution, not converting mL to litres, not using the pH equation correctly.	H10
Question 4 C HCl is always a strong acid. In risk assessments it will have become apparent to students that concentrated acids should always be added carefully to water.	H11
Question 5 B Carbon dioxide increases in solubility at lower temperatures.	H2
Question 6 A Transuranic elements have an atomic number greater than 92. The element Pu is the only product with such an atomic number.	H6
Question 7 D Metal W displaces all the other ions ∴ it is the most reactive. The ions of metal Z are displaced by all the other metals ∴ it is the least reactive. Metal Y displaces X ions so Y is more reactive than X.	H14
Question 8 C This is the only compound name that has 3 chlorine atoms and 3 fluorine atoms joined to an ethane molecule producing a different structural formula to that shown in the diagram.	H6
Question 9 C Zinc is oxidised; mercury(II) is reduced. The electrolyte needs to be ionic, therefore it is the potassium hydroxide paste.	H6, H7
Question 10 D This equation represents an acid/base reaction. It also correctly identifies that the neutralisation process is exothermic.	H7
Question 11 D Each of the bonds in NCl_3 is a single covalent bond.	H6
Question 12 B Since no precipitation occurred, chloride could not be present. Carbonate can only be confirmed if the addition of acid produced effervescence; the gas evolved would then have to change lime water to a milky appearance.	H14
Question 13 C Since absorbance is proportional to [ion], we have a ratio of 1:5 from the gradient of the curve. At an absorbance off 33%, the concentration would be calculated as being $33 \times 5 = 165$.	H10

Part A (Continued)

Answer and explanation	Outcomes assessed
Question 14 C The percentage by volume can be converted into ppm by finding the corresponding percentage from a million particles. $\therefore$ 0.0005% $\times$ 1 000 000 = 5 ppm $\therefore$ 0.0001% $\times$ 1 000 000 = 1 ppm	H13
Question 15 D In this case, the oxidation number changes by a value of 2; in the other cases the oxidation number only changes by a value of 1.	H6

Part B

Sample answer	Syllabus outcomes and marking guide
Question 16	H2
The Lowry Bronsted theory of acids and bases defines an acid as a proton donor. The Lewis theory defines an acid as being able to form a covalent bond using a lone pair of electrons from another substance (an acceptor of an electron pair). In the example given, the equation for the ionisation of water is $2H_2O \rightleftharpoons H_3O^+ + OH^-$ According to the Lowry Bronsted theory, one water molecule donates a proton to the other molecule. The donating molecule is the acid and the molecule which accepts the proton is the base. The Lewis theory would explain the formation of H_3O^+ by the donation of the pair of electrons by one water molecule to the H^+ ion released from the other molecule to form a coordinate covalent bond and the H_3O^+ ion. The water molecule is the base and the proton is the acid. In both cases the water molecule accepting the proton is the base. The proton is an acid in terms of the Lewis theory but by the Lowry Bronsted definition, the water molecule is the acid.	• Demonstrates in depth understanding of the two theories and uses equations or diagrams for the information given to illustrate the Lowry Bronsted theory of acids as proton donors and the Lewis theory of acids as electron acceptors. . . . . 3–4 • Demonstrates a sound knowledge of the two theories and is able to apply them to one of the equation for the ionisation of water . . 2 • Recalls knowledge of the two theories 0–1
Question 17	H10
(a) The object to be plated is the cathode. The cathode is the site of the reduction process. The cations (Cr ions) are attracted to the cathode which is negative and so are deposited at that electrode. Electrons are given up at the cathode.	• Correct statement of the object as the cathode and explanation demonstrating knowledge of cathode as site of reduction 1
(b) Electroplating is used for protection against corrosion and to give improved appearance.	• Explanation demonstrating knowledge of the uses of electroplating 1
Question 18	H4
(a) For example : Poly-3-hydroxybutyrate made by the bacterium *A. Eutrophus.*	• Correctly named bioploymer . . . . . 1 • Correctly named organism or enzyme . . . 1
(b) Biopolymer research is developing alternatives to fossil fuels as raw materials for polymers. Genetically engineered enzymes or colonies of bacteria manufacturing biopolymers using biomass are all renewable resources. Fossil fuel resources will be conserved and the pollution associated with drilling and mining will be reduced. Biopolymers are also biodegradable. This will reduce visual environmental pollution and reduce and the need to acquire space for landfill disposal of traditional plastics that may take hundreds of years to break down. It is possible that "designer" polymers will be able to be produced for specific purposes with particular properties using biopolymer techniques.	• Demonstrates an extensive understanding of the reasons for developing biopolymers and the effect on the environment that will result from their widespread introduction . . . . . 3 • Demonstrates a sound knowledge of the reasons why biopolymer research will benefit society and the environment . . . . 2 • Recalls that biopolymers provide an alternative to using plastics made from fossil fuels 0–1
Question 19	H8, H9
The process of catalytic cracking is the breaking of large molecules to produce desirable smaller molecules using an inorganic catalyst (a zeolite or an aluminium silicate) to increase the surface area for the reaction and lower the energy required for the reaction to proceed.	• Correct, detailed description of the process of catalytic cracking. . . . . 3 • Description which includes formation of smaller molecules and requirement of catalyst, with mention of increased surface area or lower activation energy . . . . . 2 • Description which includes formation of smaller molecules and use of a catalyst . . 1

Part B (Continued)

Sample answer	Syllabus outcomes and marking guide
Question 20	H 9
(a) One test tube will decolourise the bromine water rapidly, forming two layers. The other test tube will decolourise slowly.	• Description demonstrating understanding of the difference between reactions of alkanes and alkenes with bromine water 1–2
(b) The test tube that decolourises rapidly contains hexene and the other test tube contains hexane. Hexene has a C=C bond which reacts with the Br_2.	• Correctly identifies the test tube that decolourises rapidly as containing hexene and the other test tube containing hexane 1
Question 21	H 4
(a) Biomass is the material produced by living organisms.	• Correct definition of biomass..... 1
(b) Water	• Correct identification of the second product as water..... 1
(c) Cellulose is the main component of biomass. There is no efficient way of converting cellulose to glucose to produce say ethanol from fermentation that could then be dehydrated to ethene to replace petrochemical sources. However, cellulose is used to make fabrics such as rayon or viscose for clothing and substances such as celluloid for filmmaking. Although cellulose has been widely used to make these products it is still not possible to use cellulose to replace polymers or substances produced from petroleum despite the potential.	• Discussion of the potential of cellulose as a raw material giving reasons for and against its use in the production of petrochemicals and giving named examples..... 3 • Discussion of the potential of cellulose as a raw material giving reasons for and against its use in the production of petrochemicals..... 2 • Recalls that cellulose has the potential to replace petroleum or gives an example of the use of cellulose in products 1
Question 22	H8, H9
(a) $CH_3CH_2OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$	• Correctly balanced equation 1
(b) (i) $CO_{(g)}$, $CO_{2(g)}$ because it contributes to greenhouse gases, $C_{(s)}$ and other particulates, oxides of nitrogen, unburnt hydrocarbons including benzene and toluene and possibly lead	• Identification of pollutants demonstrating an in depth knowledge 1
(ii) Ethanol can be regarded as less polluting because there are no unburnt hydrocarbons present to contribute to photochemical smog. Both petrol and ethanol produce $CO_{2(g)}$ which contributes to global warming. (If the temperature of the ethanol combustion engine was lower than the petrol engine, then $NO_{2(g)}$ would not be produced at all as $O_{2(g)}$ combines with the $N_{2(g)}$ in the atmosphere at high temperatures. This would reduce the buildup of ozone in the atmosphere at ground level.)	• Explanation of the reasons why ethanol can be less polluting than petrol demonstrating sound knowledge of the chemical reactions involved 1
(c) The bonds between the C and O and O and H atoms in the molecule are polar, creating a polar molecule that can dissolve polar substances. It can also form H bonds with other substances containing C, O or F which makes it an ideal solvent for substances such as glucose, amino acids and organic acids.	• Description of ethanol is a polar molecule demonstrating understanding of the nature of hydrogen bonding ..... 2 • Recall of ethanol as a polar molecule that can dissolve polar substances 1

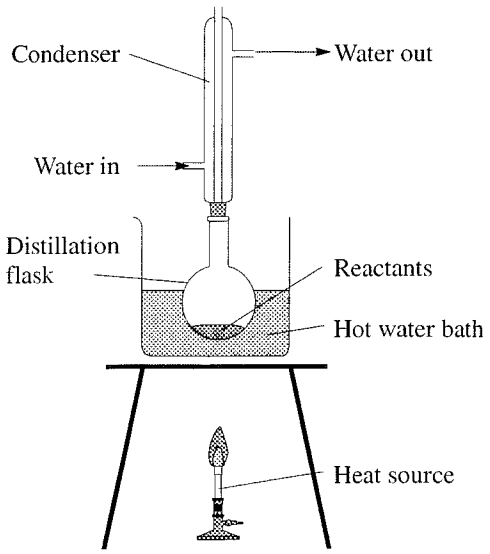
Part B (Continued)

	Sample answer	Syllabus outcomes and marking guide
Question 23		H4, H10
(a)	$(NH_4)_2SO_{4(aq)} + Ba(NO_3)_{2(aq)} \rightarrow BaSO_{4(s)} + NH_4NO_{3(aq)}$ $n(BaSO_4) = \frac{\text{mass}}{\text{molar mass}}$ $= \frac{1.45}{233.9}$ $= 6.2 \times 10^{-3}$ mol	• Identification of 6.2×10^{-3} mol of barium sulfate formed 1
(b)	By molar ratio, $BaSO_4$:N is 1:2. $n(N) = 0.0124$ mol $m(N) = n \times M$ $= 0.0124 \times 14.01$ $= 0.174$ g	• Identifcation of 0.174 g of nitrogen in the fertiliser sample 1
(c)	% by mass N in fertiliser $= \frac{0.174}{11.35} \times 100$ $= 1.53$ %	• Identification of 1.53% nitrogen in the fertilizer. 1
(d)	• Nitrogen in fertiliser is usually present as ammonium salt. The overuse of ammonium-containing fertiliser leads to ammonium poisoning of the plants and increase of the acid content of the soil above that suitable for plant growth. • Fertiliser unnecessarily high in N, if overused, contributes to run off into waterways and produces algal blooms.	• An explanation giving a reason why the content of N in fertiliser is monitored demonstrating understanding of its potential impact. 1
Question 24		H4, H9
(a)	From insulation, refrigeration and air conditioning fluids or cleaning electronic circuit boards.	• Identification of two sources of CFCs . . . 2
(b)	Ozone in the stratosphere absorbs most of the UV-B or short wavelength (320–280 nm) radiation that damages living tissue. This reduces the harm caused by sunburn, skin cancer, cataracts on the lens of the eye and diminished immune response. Ozone also absorbs that proportion of the damaging UV-C radiation (wavelengths shorter than 280 nm) not absorbed by oxygen. While providing this protection from harmful radiation, ozone allows the transmission of UV-A, which provides the energy for photosynthesis and forms Vitamin D in humans.	• Description of the benefits of ozone demonstrating well developed knowledge of the types of radiation absorbed and transmitted by ozone and the benefits of absorption or transmission. . . . . 2 • Description of the benefits of ozone demonstrating sound knowledge of the benefits of absorbing UV radiation 1
(c)	CFCs react in the stratosphere according to the following equations: $CCl_3F + \text{uv light} \rightarrow Cl + CCl_2F$ $CCl_2F + \text{uv light} \rightarrow Cl + CClF_2$ These chlorine atoms react with ozone to produce oxygen and the free radical ClO. $Cl + O_3 \rightarrow ClO + O_2$ Any free O atoms in the atmosphere as the result of the breakdown of ozone are then used to create more Cl atoms. $ClO + O \rightarrow O_2 + Cl$ The Cl continues to be produced in these reactions and can continue to reduce the concentration of ozone. There is a chain reaction set up continually destroying the ozone.in the stratosphere.	• An account of the ozone-destroying reaction of CFCs demonstrating a high level of knowledge about the initial reactions of the CFCs with uv light to produce Cl atoms and the nature of the chain reactions which follow . . . . . 2 • An account of the ozone destroying reactions of CFCs demonstrating understanding of the nature of the initial reaction with uv light and a following chain reaction. 1

Part B (Continued)

Sample answer	Syllabus outcomes and marking guide
Question 25	H2, H8
(a) Eutrophication is the process by which bodies of water become enriched with dissolved nutrients. The sources of these nutrients are usually run off from agricultural land where fertilisers have been used and discharge of raw or partly treated sewerage.	• Correct definition of eutrophication and complete identification of two sources of nitrates and/or phosphates . . . . . 3 • Correct definition of eutrophication and identification of one source of nutrient enrichment OR • identification of two sources of nitrates and/or phosphates . . . . . 2 • Correct definition of eutrophication. 1
(b) Nitrogen and phosphate are the limiting nutrients for plant growth. Therefore the value of these nutrients from all sources gives the best indication of the level of eutrophication. 1. Kjeldahl method for nitrogen in organic material. 2. Nitrates present are determined by colorimetric methods because other methods are not sensitive enough. 3. Phosphorous: A coloured solution of molybdenum blue is produced when ascorbic acid is added and the absorbance compared to standard solutions. The N:P ratio can be calculated as visible eutrophication occurs at a ratio of 10:1. However it is the level of total nitrogen above 0.1–1 ppm and 0 .001–0.1 ppm for phosphorous that indicates possible eutrophication.	• Discussion of the methods used which notes the importance of assaying the total nitrogen and phosphorous of a water sample to determine value of the N:P ratio . . . . . 3 • Discussion which gives a basic description of one or two tests and includes a comparison of some relevant features . . . 2 • A response which refers to one of the tests for eutrophication 1
(c) Phosphate and nitrate levels in water usually limit plant growth and an ecological balance is reached. When the levels of P and N are high growth of algae and/or cyanobacteria continues unchecked and algal blooms form which prevent sunlight penetrating the water and stop atmospheric oxygen mixing with the water, reducing the dissolved oxygen (DO) available for other living things. At night the algae use the dissolved oxygen in the water for respiration, which further depletes the dissolved oxygen content. The biochemical oxygen demand (BOD) is the quantity of oxygen required to respire organic waste in a body of water. The algal bloom reduces the oxygen available to other living things to the point where the BOD is greater than the DO and living things die. When the nutrient in excess supply is used by the algae, the algae themselves die and consume all available oxygen in the water until they eventually decay anaerobically producing a solid mass of substance which results in the death of all living things in the waterway.	• An analysis of the effects of eutrophication demonstrating a high level of knowledge and understanding of the sequence of events that leads to the death of living things in waterways. The answer will include reference to dissolved oxygen and/or biochemical oxygen demand. . . . . 4 • An analysis of the effects of eutrophication demonstrating knowledge and understanding of the sequence of events that leads to the death of living things in waterways. The answer may include reference to dissolved oxygen or biochemical oxygen demand. . . . . 2–3 • Recall of the effects of eutrophication on waterways. 1

Part B (Continued)

Sample answer	Syllabus outcomes and marking guide
Question 26	H8
(a) A decrease in the temperature will drive the reaction in the direction that produces more heat, which is to the right, increasing the amount of ammonia. An increase in pressure will drive the reaction in the direction that reduces pressure, which is the side with fewer molecules of gas (according to the chemical equation), so it will shift to the right, increasing the amount of ammonia.	• Demonstrates understanding of the effect of changes on an equilibrium system according to Le Chatelier's principle 2
(b) The increase in rate due to higher temperatures is much more significant than the decrease in yield.	• Correctly identifies the reason 1
Question 27	H7, H8, H11
(a) X is butanoic acid, $CH_3CH_2CH_2COOH$. Its boiling point is much higher than the other possible reactant, ethanol. Butanoic acid has a higher molecular mass, hence greater dispersion forces than ethanol, and it also has two sites available for hydrogen bonding, whereas ethanol only has one.	• One mark for identification and drawing of butanoic acid • One mark for justification identifying its greater dispersion forces or larger number of sites for hydrogen bonding 2
(b)  The process is refluxing and it is used to increase the reaction rate. This is done by mixing the reactants together with a small amount of concentrated sulfuric acid (or phosphoric acid) and heated appropriately (water bath/oil bath/heating mantle - NOT direct heat). A water jacketed condenser or air condenser cools the product and reactant vapours so that they fall back into the reaction vessel.	• Two marks for correctly drawing and labelling the equipment • One mark for describing the process of refluxing 3
Question 28	H10, H14
(a) A primary standard needs to be of high purity and sufficiently stable so that it does not deliquesce as it is being weighed. An example of such a chemical would be anhydrous sodium carbonate.	• Correct identification of a primary standard and discussion of its relevant properties . 2 • An example of a primary standard or a property. 1

Part B (Continued)

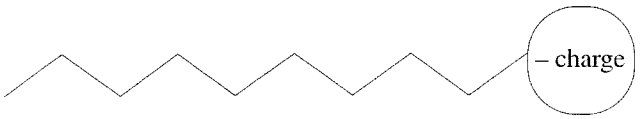
Sample answer	Syllabus outcomes and marking guide
(b) $n(\text{citric acid}) = \frac{n(\text{NaOH})}{3}$ $= \frac{0.040 \times 0.075}{3}$ $m(\text{citric acid}) = n(\text{citric acid}) \times M$ $= \frac{0.040 \times 0.075}{3} \times 192$ $= 0.192 \text{ g}$ Undiluted sample contains $0.192 \times \frac{250}{25} = 1.92 \text{ g}$ % w/v of citric acid is $\frac{1.92}{25} = 7.68\%$	• One mark for n(citric acid) in dilute sample • One mark for m(citric acid) in dilute sample • One mark for converting to undiluted sample • One mark for correct %w/v 4

Section II

Question 29 Industrial Chemistry

		Sample answer	Syllabus outcomes and marking guide
(a)	(i)	Sulfuric acid has a strong affinity for water. It will quickly dehydrate many organic molecules. $C_{12}H_{22}O_{6(s)} \xrightarrow{\text{Conc. } H_2SO_4} 12C + 11H_2O_{(g)}$	H7, H9 • A correct equation 1
	(ii)	Wear appropriate eyewear, lab-coat and gloves. Add acid in small amounts to a large volume of water.	• One mark for safe technique • One mark for identifying safety equipment. 2
(b)		Biodegradable detergents are capable of being broken down by bacteria and other decomposers. This means they do not remain in the environment for long periods. Phosphate is a problem in the environment because it acts as a nutrient to promote the growth of algae to a point where it overwhelms the ecological balance eventually causing oxygen depletion and the death of aquatic life.	H13, H15 • Clearly explains what is meant by "biodegradable" and the environmental advantages of biodegradable and phosphate-free cleansers ..... 2 • Describes biodegradability OR • Mentions a relevant environmental advantage of biodegradable or phosphate-free cleansers 1
(c)	(i)	Acting as a means of precipitating an insoluble sulfate salt.	H8 • Correct answer 1
	(ii)	Acting as an oxidising agent.	• Correct answer 1
	(iii)	Acting as an acid.	• Correct answer 1
(d)		Moderate temperature to enable a reasonable rate of reaction coupled with an acceptable yield (reaction is exothermic and therefore favoured by lower temperatures). The high pressure favours the formation of product as four mole of reactants are reduced to two mole of product. Pressure would also increase rate. The catalyst increases the rate at which equilibrium is obtained. (Does not affect the extent of reaction). • The removal of ammonia would favour formation of product. • A slight excess of a reactant would favour production of the product.	H3, H8 • One mark for correctly explaining temperature • One mark for correctly explaining pressure • One mark for correctly explaining catalyst • One mark for correctly identifying the effect of the amount of reactant or products present 4
(e)	(i)	Compound 1 is carbon dioxide. Compound 2 is calcium oxide (lime). $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$	H9, H13 • Correct equation 1
	(ii)	$2NaHCO_{3(s)} \rightarrow Na_2CO_{3(s)} + H_2O_{(g)} + CO_{2(g)}$	• Correct equation 1
	(iii)	1) $NH_{3(aq)} + CO_{2(g)} + H_2O_{(l)} + NaCl_{(aq)} \rightleftharpoons NH_4Cl_{(aq)} + NaHCO_{3(s)}$	• Correct equation 1
		2) $n(NH_3) = n(NaHCO_3)$ $n(NaHCO_3) = \frac{200 \times 10^3}{84}$ $m(NH_3) = \frac{200 \times 10^3}{84} \times 17$ $m(\text{ammoniacal brine}) = \frac{200 \times 10^3}{84} \times 17 \times \frac{100}{7}$ minimum mass $= 578.2$ kg	• One mark for correct expression or value for $n(NaHCO_3)$ • One mark for correct expression or value for $m(NH_3)$ • One mark for correct value for minimum mass of ammoniacal brine 3

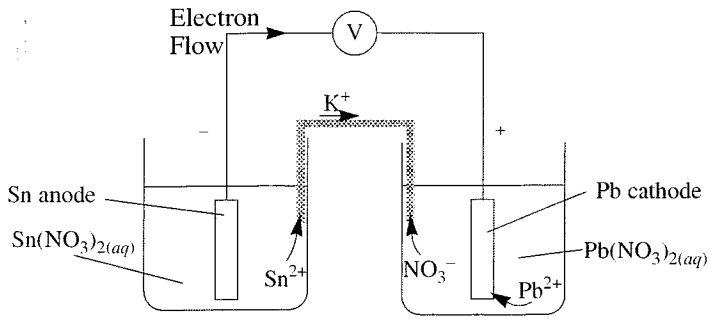
Question 29 Industrial Chemistry (Continued)

		Sample answer	Syllabus outcomes and marking guide
(f)	(i)	Triglycerides are reacted with concentrated sodium hydroxide and heated with steam. This hydrolyses the triglyceride producing a sodium salt of the long chain fatty acid (the soap) and glycerol.	H7, H13, H16 • Correctly explains the use of concentrated sodium hydroxide and steam in the hydrolysis of triglycerides and which correctly identifies the soap as the sodium salt of a fatty acid. . . . . 2 • Mentions hydrolysis and the use of sodium hydroxide OR • Mentions hydrolysis and correctly identifies the soap as a sodium salt of a fatty acid. . 1
	(ii)	The soap contains a long carbon chain that is hydrophobic attached to a hydrophilic carboxyl group carrying a negative charge.  The charged head of the molecule is attracted to water molecules while the 'tail' buries itself in the grease. Agitation of the washing water begins to pull the grease away from the surface. Many molecules attach themselves in this manner making the outside of the grease appear to be covered in a hydrophilic layer that is stable in water.	• Describes soap structure and action of cleaning . . . . . 2 • Mentions hydrophobic non-polar 'tail' and hydrophilic polar head OR • A resonable attempt at an explanation of removal of grease 1
(g)	(i)	Sodium hydroxide is produced by electrolysis of brine. The process uses energy to produce less stable products than the reactants i.e. chlorine, hydroxide and hydrogen.	H3, H7, H13 • Correctly states that the products of the electrolysis are higher energy/less stable. 1
	(ii)	The cells are designed with a cathode and an anode in separate areas so that the reactive products are kept separated.	• Correctly mentions the separation of cathode and anode 1
	(iii)	Mercury cell: possible release of mercury into the environment. Diaphragm cell: Possible danger due to asbestos. Sodium hydroxide produced contains a reasonably high percentage of NaCl (~2%) Membrane cell: Produces high purity NaOH	• Any one advantage or disadvantage of a correctly named cell. 1

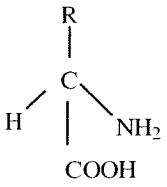
Question 30 Shipwrecks and Salvage

		Sample answer	Syllabus outcomes and marking guide
(a)	(i)	At great depths the temperature of water would be very low, resulting in a very slow rate of reaction for the corrosion process.	H8 • Correctly relates rate of reaction with depth of water 1
	(ii)	For the equation $O_{2(g)} \rightleftharpoons O_{2(aq)}$ According to Le Chatelier's Principle, an increase in pressure would shift the equilibrium to the right, therefore increasing the concentration of dissolved oxygen in the water.	• One mark for correctly applying Le Chatelier's principle • One mark for correctly writing equation . 2
	(iii)	1) Depletion at such great depths can be the result of aerobic organisms closer to the surface using up the oxygen and so no oxygen is left to diffuse to deeper water.	• A correctly stated reason 1
		2) Anaerobic means without the need of oxygen.	• Correct definition. 1
		3) The reduction of sulfur by anaerobic bacteria allows the oxidation of iron to take place.	• Correctly referring to the role of sulfur in the oxidation of iron. 1
(b)	(i)	A sample of pure iron and a sample of steel are placed into water (or salt water solution). The samples are left in the water for a specified period and then compared for their relative amounts of corrosion. To make the investigation a fair comparison, the temperature of water, concentration of ions in the water and amount of air available to each sample would need to be the same.	H8 • One mark for identifying steps of the experiment • One mark for identifying the need for maintaining constant water temperature, concentration of ions and amount of air available for each sample. 2
	(ii)	Passivating metals form an unreactive surface coating with substances such as oxygen, sulfur and/or air. These layers prevent further corrosion because they are impermeable thus preventing the metal beneath the coating to be exposed to further reaction. Active metals produce a surface coating which is permeable. This allows reactants such as oxygen and water to move through the layer and thus cause further corrosion of the metal.	• Correctly identifying the presence of impermeable oxide or sulfide layers in passivating metals and permeable layers in non-passivating metals. . . . . 2 • Correctly states that an impermeable oxide/sulfide layer may be formed in passivating metals 1
(c)	(i)	$2Br^-_{(aq)} \rightarrow Br_2 + 2e^-$	H8 • Correct equation 1
	(ii)	The formation of bromine, the source of the brown colour, occurs at the anode. This is known because it is the result of oxidation.	• One mark for correctly identifying anode • One mark for a correct reason 2
	(iii)	$H_2O + e^- \rightarrow \frac{1}{2}H_2 + OH^-$	• Correct equation 1

Question 30 Shipwrecks and Salvage (Continued)

Sample answer	Syllabus outcomes and marking guide
(d)  $Sn_{(s)} \rightarrow Sn^{2+} + 2e^-$ $\quad$ $Pb^{2+} + 2e^- \rightarrow Pb_{(s)}$ Standard Potential = $E^\circ = 0.14 + (-0.13) = 0.01$ V	H8 • One mark for correctly labelled electrodes and solutions • One mark for correctly identified contents of salt bridge • One mark for correct direction of electron flow • One mark for correct direction of ion flow • One mark for correct half equations • One mark for correctly calculated potential 6
(e) Examples: • Modern rust-preventing paints create an impermeable layer that prevents oxygen and water passing through to the iron below. Additives in the paint react with surface atoms in the steel to produce a layer of very insoluble salt which prevents the migration of ions and therefore stops electron transfer reactions taking place. • Surface alloys are the result of gaseous metal ions (plasma) of chromium and nickel being directed onto the surface of steel. The ions become embedded as atoms and create a passivating layer on the surface of the steel. • Sacrificial anodes can be used to provide protection to steel hulls. A metal is in contact with the steel hull. This sacrificial anode is allowed to corrode (oxidise) thus allowing electrons to travel to the steel hull which acts as the cathode. Since the hull receives electrons, it is unable to oxidise. This method can be performed in two different ways 1. Using a more active metal as the sacrificial anode and therefore creating a galvanic cell. 2. Using a power supply to force electrons onto the hull, thus creating an electrolytic cell.	H8 • Two correctly named methods with explanations of how each prevents corrosion . . . . . 3–4 • One correctly named method with explanation. . . . . 2 • One correctly named method with relevant properties mentioned OR • Two correctly named methods. 1
(f) As the artefact starts to dry, the ions in the solution start to solidify. The formation of the ionic crystals throughout the porous material can result in that materials shape being distorted, its body cracking or the components in the material chemically reacting with the salt.	• A correctly identified change. 1

Question 31 Biochemistry of Human Movement

		Sample answer	Syllabus outcomes and marking guide
(a)	(i)	The cytosol or cytoplasm	H7, H9, H10 • Correct answer 1
	(ii)	2 ATP, 2 Pyruvate and 2 NADH	• Two or more correctly identified products 1
	(iii)	The oxidation of fats provides many more Acetyl Co A molecules for the TCA Cycle to produce more ATP per gram than carbohydrates in all tissues except the brain. The electron carriers NADH and $FADH_2$ are also produced each time 2 C atoms for Acetyl Co A are removed from the fatty acid, providing more energy via oxidative phosphorylation.	• Clearly explains the role of fats as a fuel supply . . . . . 2 • Mentions that fats provide more energy in the form of ATP than carbohydrates 1
(b)	(i)	Acetyl Co A is the substrate oxidised to form CO_2.	H7,H9, H10, H13 • Correctly identified substances 1
	(ii)	NAD^+ and FADH are reduced to NADH and $FADH_2$	• A correctly identified pair 1
	(iii)	NADH and $FADH_2$ transfer electrons gained from the oxidation of Acetyl Co A to the electron transport chain. As the electrons are transferred to the acceptor molecules energy is released which is used to drive H^+ ions across the membrane, generating an H^+ ion gradient. This gradient provides the energy for the production of ATP from ADP and Pi. The electrons are eventually transferred to O_2 that combines with H^+ to produce water.	• Demonstrates extensive knowledge of oxidative phosphorylation . . . . . 4 • Shows sound knowledge of the process. . 3 • Demonstrates knowledge of some of the parts of oxidative phosphorylation. . . . . 2 • Mentions only one correct aspect of oxidative phosphorylation 1
	(iv)	The enzymes that catalyse the oxidative phosphorylation reactions are found in the inner membrane of the mitochondrion that is extensively folded into the cristae. The H^+ ions are pumped into the intermembrane space during the reactions and O_2 diffuses in to combine with the H^+ to form water. This arrangement confines the reactants to the membrane and the space between it and the mitochondrion wall. The soluble enzymes that catalyse the TCA Cycle and the oxidation of fatty acids are found in the matrix.	• Clearly explains the use of spaces and membranes in the mitochondrion . . . . . 2 • Correctly identifies some sites within the mitochondrion and their roles in one of the given processes . 1
(c)	(i)	The structural units of enzymes are amino acids. Each acid contains an amine group (NH_2), a carboxylic acid group (COOH) and one other functional group (R).  	H2, H13 • Correctly identifies and draws an amino acid and correctly identifies two of the functional groups . . . . . 2 • Correctly identifies and draws amino acid OR • Correctly identifies at least two functional groups 1