2017 HSC Chemistry Marking Guidelines

Section I, Part A

Multiple-choice Answer Key

Question	Answer
1	A
2	D
3	A
4	D
5	A
6	B
7	C
8	C
9	D
10	B
11	D
12	D
13	B
14	A
15	B
16	B
17	C
18	D
19	C
20	C

Section I, Part B

Question 21 (a)

Criteria	Marks
• Outlines ONE effect of ozone in troposphere and ONE effect in stratosphere	2
• Identifies ONE effect of ozone in troposphere OR stratosphere	1

Sample answer:

Troposphere – ozone acts as a pollutant, causing respiratory problems.
Stratosphere – ozone acts as a UV radiation shield by absorbing UV.

Question 21 (b)

Criteria	Marks
• Qualitatively compares TWO properties of O_2 and O_3	2
• Qualitatively compares ONE property of O_2 and O_3 OR • Identifies TWO properties of the molecules	1

Sample answer:

Ozone has a higher boiling point than oxygen. Ozone is less stable than oxygen.

Question 21 (c)

Criteria	Marks
• Provides a correct equation with or without states	1

Sample answer:

$O_3(g) + Cl\bullet(g) \rightarrow ClO\bullet(g) + O_2(g)$

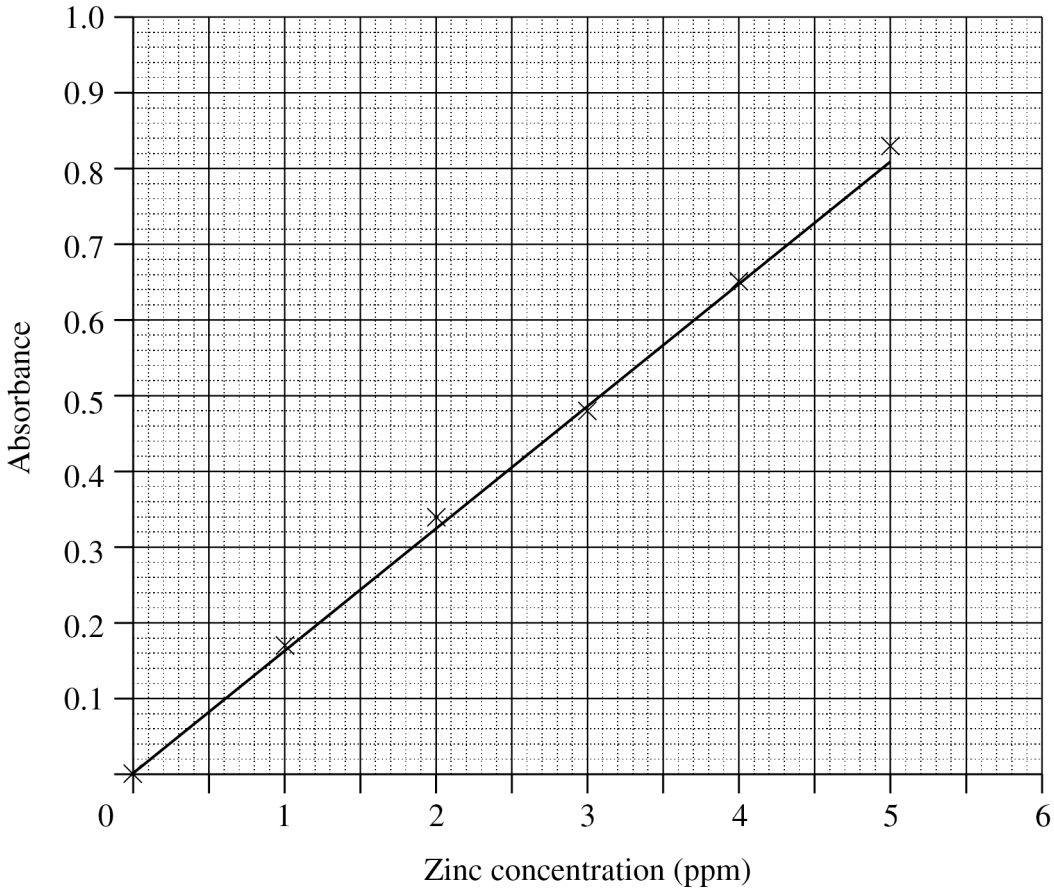
Answers could include:

A series of equations could be accepted.

Question 22 (a)

Criteria	Marks
• Labels axes correctly including units • Uses appropriate scale • Plots points correctly • Draws appropriate line of best fit	3
• Provides a substantially correct graph	2
• Includes ONE correct feature	1

Sample answer:



Question 22 (b)

Criteria	Marks
• Provides an explanation of whether the water is safe for drinking based on correct interpretation of the student's graph or data provided	2
• Provides some relevant information	1

Sample answer:

From the graph, the zinc concentration is 3.6 ppm. This is greater than the concentration considered safe for drinking water. Therefore the water is not safe for drinking.

Answers could include:

From the graph, 2.8 ppm equals approximately 0.46 absorbance. 0.58 absorbance is higher. Therefore the water is not safe to drink.

Question 23 (a)

Criteria	Marks
• Provides an explanation of why a salt bridge is required	2
• Identifies a function of a salt bridge	1

Sample answer:

The salt bridge completes the circuit in a galvanic cell. It allows movement of ions between solutions to maintain electrical neutrality in each half-cell.

Question 23 (b)

Criteria	Marks
• Correctly calculates the new mass showing working	4
• Provides substantially correct working	3
• Provides a relevant step and equation OR • Provides some relevant steps	2
• Provides ONE relevant step	1

Sample answer:

$n = \dfrac{m}{M} \qquad n_{zn} = \dfrac{1.00}{65.38} = 0.015295 \text{ mol}$

$Zn + 2Ag^{+} \rightarrow Zn^{2+} + 2Ag$

Molar ratio $Zn : Ag = 1:2$

$\therefore 2 \times 0.015295 = 0.030590 \text{ mol Ag formed}$

$m = nM \qquad m = 3.29979 \text{ g}$

$= 3.30 \text{ g gained}$

New mass silver electrode $= 10.0 + 3.30$

$= 13.3 \text{ g}$

Question 24 (a)

Criteria	Marks
• Calculates concentration of NaOH to four significant figures showing working	3
• Provides substantially correct working	2
• Provides ONE relevant step	1

Sample answer:

$$c = \frac{n}{v} \quad n = cv$$

$$n_{acetic} = 0.5020 \times 0.02500$$

$$= 0.01255 \text{ mol}$$

Molar ratio 1 : 1

$$\therefore C_{NaOH} = \frac{0.01255}{0.01930} = 0.6503 \text{ mol L}^{-1}$$

Question 24 (b)

Criteria	Marks
• Provides a correct explanation including a relevant equation	2
• Provides a relevant equation OR • Provides some valid explanation	1

Sample answer:

Because the acetate ion is a weak base, it has accepted a proton from the water resulting in production of hydroxide ions. Therefore the solution has a pH > 7.

$CH_3COO^-(aq) + H_2O(l) \rightleftharpoons CH_3COOH(aq) + OH^-(aq)$.

Question 25

Criteria	Marks
• Outlines the steps in the conversion of cellulose to polyethylene • Provides relevant equations	4
• Outlines the main steps in the conversion of cellulose to polyethylene • Provides at least one relevant equation	3
• Identifies relevant steps in the conversion of cellulose to polyethylene OR • Provides substantially correct equations OR • Identifies a relevant step and a substantially correct equation	2
• Identifies ONE relevant step or equation	1

Sample answer:

Cellulose is a condensation polymer and can be broken down into glucose monomers. Glucose can be fermented to ethanol.

Fermentation $C_6H_{12}O_6(aq) \xrightarrow{yeast} 2CH_3CH_2OH(aq) + 2CO_2(g)$.

Ethanol can then be dehydrated to ethylene.

Dehydration $CH_3CH_2OH \xrightarrow{H_2SO_4(conc)} CH_2 = CH_2 + H_2O$.

Polymerisation of ethylene forms polyethylene.

Question 26 (a)

Criteria	Marks
• Outlines TWO reasons	3
• Identifies TWO reasons OR • Outlines ONE reason	2
• Identifies ONE reason	1

Sample answer:

Sulfur dioxide release is a concern for human health because even at low concentrations it irritates the respiratory system and causes breathing difficulties. Because SO_2 dissolves in water droplets, it forms acid rain that has adverse effects on the environment, for example breaking down waxy surfaces of leaves leading to deforestation.

Question 26 (b)

Criteria	Marks
• Explains the varying concentrations of SO_2 with reference to the map • Provides relevant equations	4
• Outlines factors that contribute to the varying concentrations of SO_2 • Provides at least one relevant equation	3
• Provides substantially correct equations OR • Outlines a factor that contributes to the varying concentrations of SO_2 OR • Identifies a factor that contributes to the varying concentrations of SO_2 and provides a substantially correct equation	2
• Provides some relevant information	1

Sample answer:

While sulfur dioxide is continually added to the atmosphere from geothermal sources, the main human activities that release sulfur dioxide are burning fossil fuels such as coal containing sulfur $S(s) + O_2(g) \rightarrow SO_2(g)$ or extracting metals from sulfide ores, for example at the smelter $2PbS(s) + 3O_2(g) \rightarrow 2PbO(s) + 2SO_2(g)$.

Both these processes have resulted in localised high levels of SO_2 but have not spread across the region. This is both because SO_2 levels are low in absolute terms and readily diluted in the atmosphere and because SO_2 dissolves in water and is removed from the atmosphere by rain. Sulfur dioxide reacts to form sulfurous acid:

$SO_2(g) + H_2O(l) \rightarrow H_2SO_3(aq)$ and is then converted to sulfuric acid.

Question 27

Criteria	Marks
• Explains why the three compounds have very different molar masses but similar boiling points in terms of their structure and bonding	5
• Outlines why the three compounds have very different molar masses but similar boiling points in terms of their structure and/or bonding	4
• Shows some understanding of the structure and/or bonding of the three compounds	2–3
• Provides some relevant information	1

Sample answer:

Despite having different molar masses, all three molecules have similar boiling points due to their different structures and resulting intermolecular forces.

Butyl acetate has the largest molar mass and therefore greatest dispersion forces but it is only slightly polar and has no hydrogen bonding.

Butan-1-ol has lower molar mass than butyl acetate and therefore smaller dispersion forces but it is polar and contains a hydrogen bound to an oxygen. Therefore, it exhibits hydrogen bonding resulting in strong intermolecular forces.

Acetic acid has the lowest molar mass and so the weakest dispersion forces but it is polar and contains a hydrogen bound to an oxygen allowing the formation of hydrogen bonds between molecules. The presence of a second oxygen in acetic acid increases the hydrogen bonding compared with butan-1-ol.

Therefore, all three molecules have similar total strength of intermolecular forces and therefore similar boiling points.

Question 28 (a)

Criteria	Marks
• Outlines TWO advantages and TWO disadvantages of using ethanol as an alternative fuel for motor vehicles	4
• Outlines advantages and/or disadvantages of using ethanol as a fuel	2–3
• Identifies an advantage or a disadvantage of using ethanol as a fuel	1

Sample answer:

Advantages:

- Ethanol can be produced from renewable sources such as sugarcane as opposed to other fuels such as petrol which come from fossil fuels, the supply of which is finite.
- Ethanol undergoes complete combustion more easily than octane therefore producing less C(*s*) which can clog engine parts, and less CO(*g*) which is poisonous.

Disadvantages:

- Ethanol releases less energy per gram than octane meaning that a greater mass of fuel is required to travel the same distance.
- Producing ethanol from renewable sources requires vast amounts of arable land, reducing the availability of land for food crops.

Question 28 (b)

Criteria	Marks
• Correctly calculates the energy generated showing working	3
• Provides substantially correct working	2
• Provides ONE relevant step	1

Sample answer:

$$C_2H_5OH(l) + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(g)}$$

$$N_{CO_2} = \frac{1000}{44.01}$$

$$= 22.72$$

$$N_{ethanol} = \frac{22.72}{2} = 11.36$$

$$\text{Energy per kg of } CO_2 = 11.36 \times 1360$$

$$= 15450 \text{ kJ}$$

Question 29

Criteria	Marks
• Provides a valid justification of one site with reference to the information provided	4
• Provides a justification of one site with reference to some of the information provided	2–3
• Provides some relevant information	1

Sample answer:

Site *Y* would be preferable as a water source.

- Although the turbidity is higher than site *X* the new purification system has a sedimentation tank where the suspended solids could be removed.
- pH is slightly acidic but this can be adjusted in the system.
- Calcium is lower than Site *X*. This is preferable as calcium ions in the water contribute to 'hardness' that prevents soap lathering and can cause build-up of precipitates on pipes. Calcium will not be removed by the new system.
- Phosphate is lower than Site *X*. At Site *X* the high phosphate could lead to algal blooms making the water toxic to livestock and humans, having low dissolved oxygen leading to fish kills and subsequent contamination. This is known as eutrophication.

Question 30

Criteria	Marks
• Provides a thorough analysis of the conditions required to optimise ammonia production using the Haber process including factors such as temperature, pressure and catalyst, and their interrelationships	7
• Describes how factors such as temperature, pressure and catalyst, and their interrelationships can optimise ammonia production using the Haber process	6
• Outlines conditions that can optimise ammonia production using the Haber process	4–5
• Outlines factor(s) that can affect the Haber Process	2–3
• Provides some relevant information	1

Sample answer:

The Haber process is an industrial process used to manufacture ammonia according to the following equilibrium reaction.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \triangle H = -92 \text{ kJ mol}^{-1}$$

In order to be economically viable it needs to produce a high yield at a reasonable rate.

Increasing the temperature will provide the reactants with more energy and therefore increase the rate of reaction. According to Le Chatelier's Principle (LCP) when a change is imposed on a system the system will adjust to minimise the change. Therefore if the temperature is increased the system will adjust to reduce the temperature by favouring the reverse, endothermic reaction and reducing the yield. As a result the process is carried out at a moderate temperature of 450°C. An iron oxide catalyst is also added to increase the rate of reaction but this has no impact on the yield.

According to LCP if the pressure is increased, the system will adjust to reduce the pressure by favouring the reaction that produces fewer moles of gas. In this process it will favour the production of ammonia, increasing the yield, but there is a limit to the pressure that the apparatus can safely withstand so it is carried out at pressures of about 300 atm.

The equilibrium mixture is also passed through a condenser to remove the ammonia, shifting the equilibrium to favour the production of more ammonia and increasing the yield.

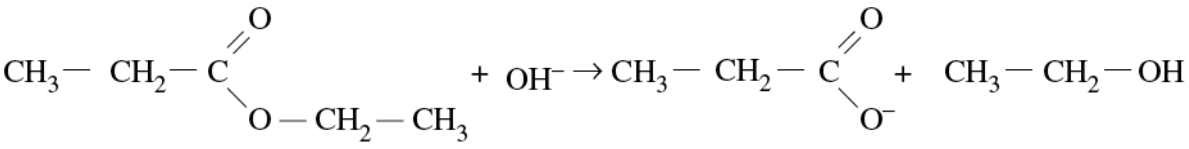
To optimise production of ammonia, it is important to monitor and maintain these conditions.

Section II

Question 31 (a) (i)

Criteria	Marks
• Writes a correct equation using structural formulae	2
• Provides some features of the equation	1

Sample answer:



Question 31 (a) (ii)

Criteria	Marks
• Describes a suitable procedure	3
• Provides some steps to carry out saponification and/or test the product	2
• Provides some relevant information	1

Sample answer:

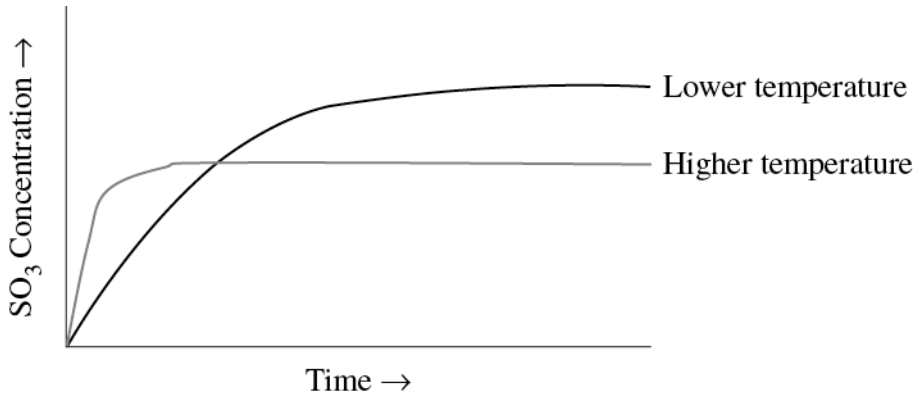
Procedure:

1. Add 5 g of olive oil, 15 mL of ethanol and 15 mL of 20% NaOH to an evaporating basin.
2. Heat and stir the mixture for approximately 30 minutes until the solution no longer has two separate layers.
3. Add approximately 50 mL of saturated NaCl solution to the solution in the evaporating basin. Stir until curds of soap float to surface.
4. Skim curds from surface. Rinse with cold water. Pat dry on filter paper.
5. Place 5 mL rainwater in a test tube with a small amount of the soap product. Invert and shake.
6. Record the quantity of foam/bubbles.

Question 31 (b) (i)

Criteria	Marks
• Sketches a correct curve on the same axes	2
• Sketches a partially correct curve	1

Sample answer:



Question 31 (b) (ii)

Criteria	Marks
• Draws a correct conclusion • Justifies conclusion using correct calculations	4
• Draws a conclusion • Justifies the conclusion with substantially correct calculations	3
• Provides some relevant calculations	2
• Provides some relevant information	1

Sample answer:

Concentration of gases in 1.0 L container, mol L^{-1}.

	Moles SO_2	**Moles O_2**	**Moles SO_3**
Initial	1.0	1.0	0
Used/made	0.70	0.35	0.70
Final	0.30	0.65	0.70

$$\frac{[SO_3]}{[SO_2].[O_2]^{\frac{1}{2}}}$$

$$= \frac{0.7}{0.3 \times 0.65^{\frac{1}{2}}} = 2.9$$

Since $2.9 \neq 12.1$, equilibrium has not been reached.

Question 31 (c) (i)

Criteria	Marks
• Identifies both products	2
• Identifies ONE product	1

Sample answer:

X = $NaHCO_3$ or sodium hydrogen carbonate.
Y = CaO or calcium oxide.

Note: Two correct products without labelling in any order can be awarded full marks.

Question 31 (c) (ii)

Criteria	Marks
• Outlines how the brine is purified • Provides a relevant chemical equation	2
• Provides some relevant information	1

Sample answer:

- Sodium carbonate is added to precipitate calcium.
- $Ca^{2+}(aq) + CO_3^{2-}(aq) \rightarrow CaCO_3(s)$.

Question 31 (c) (iii)

Criteria	Marks
• Explains the role of NH_3 in the manufacture of Na_2CO_3 • Provides relevant equation(s)	3
• Shows some understanding of the role of NH_3 AND/OR • Provides relevant equation(s)	2
• Provides some relevant information	1

Sample answer:

The brine is saturated with NH_3 so that when $CO_2(g)$ is bubbled through it and forms $H_2CO_3(aq)$ this weak acid (H_2CO_3) reacts with the weak base, NH_3, to form hydrogen carbonate ions.

$NH_3(aq) + H_2CO_3(aq) \rightarrow NH_4^+(aq) + HCO_3^-(aq)$.

Sodium ions can then combine with the hydrogen carbonate ion

$Na^+(aq) + HCO_3^-(aq) \rightarrow NaHCO_3\ (s)$.

This is an essential step in the production of sodium carbonate that would not be possible without ammonia.

Question 31 (d)

Criteria	Marks
• Shows a thorough understanding of the technical and environmental issues associated with the industrial production of sodium hydroxide • Makes an informed judgement about the extent to which technological advances have overcome the issues	7
• Outlines technical and environmental issues associated with the industrial production with the industrial production of sodium hydroxide • Shows a sound understanding of technological advances in the industrial production of sodium hydroxide • Makes some judgement about the extent to which technological advances have overcome the issues	6
• Outlines technical and/or environmental issues associated with the industrial production of sodium hydroxide • Shows some understanding of the use of technology in the industrial production of sodium hydroxide	4–5
• Identifies some technological advances and/or technical issue and/or environmental issues associated with the industrial production of sodium hydroxide	2–3
• Provides some relevant information	1

Sample answer:

NaOH is produced in an electrolytic cell using three main methods the diaphragm process, membrane process and mercury process. The overall equation is:

$$2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g) + Cl_2(g)$$

Initially the diaphragm process was used, whereby an aqueous solution of NaCl was electrolysed to form chlorine gas at the anode ($2Cl^- \rightarrow Cl_2 + 2e^-$) leaving sodium ions in solution, and water formed hydrogen gas at the cathode leaving OH^- ions ($2H_2O + 2e^- \rightarrow H_2 + 2OH^-$). NaOH formed when sodium ions could pass through an asbestos membrane to combine with the OH^- ions.

Although a high volume of NaOH was produced this way some contamination of the final product occurred. Diffusion of chloride ions into the cathode compartment forms some NaCl which compromises the purity of the NaOH formed there. In addition some OH^- ions leak back to the anode forming ClO^- ions. In the diaphragm method, this technical difficulty was overcome by maintaining a slightly positive pressure in the anode compartment. However, it required further understanding of the chemistry of polymers before technology advanced and the membrane process was developed. In this technology, a polymer membrane was inserted between the half-cells instead of the asbestos membrane. This membrane contained highly electronegative atoms like fluorine, which repelled Cl^- ions to prevent contamination.

The technical issue of contamination of the NaOH was solved in the mercury process which reduced Na^+ ions from NaCl to Na at the cathode, the Na forming an amalgam with mercury for transport to another tank where it is then sprayed with water to produce a chemical reaction that forms the desired NaOH(aq). Although the mercury can be recycled some escapes to the environment and has serious adverse effects on animals.

However, both the diaphragm and the mercury processes raised environmental and health concerns. The asbestos diaphragms required maintenance and replacement, leading to health problems in workers handling the asbestos. While the mercury method solved this by eliminating the need for asbestos, it used mercury, which could leak into the environment, contaminating waterways. Both these issues have been addressed by the newer technology of the membrane process where neither asbestos nor mercury are used. While introducing new technologies to old processing plants is expensive, all new plants now use the new membrane technology.

In my judgement, the technical and environmental issues of NaOH production have been improved to a great extent by the introduction of new technologies.

Question 32 (a) (i)

Criteria	Marks
• Outlines a suitable procedure	2
• Provides some relevant information	1

Sample answer:

- 5 nails were placed in test tubes containing 10 mL of 0.1 mol L^{-1} HCl.
- 5 identical nails were placed in test tubes containing 10 mL of distilled water.
- All test tubes were left for 5 days in the same location.
- After 5 days the nails were inspected for signs of corrosion.

Question 32 (a) (ii)

Criteria	Marks
• Explains the expected result • Includes relevant half equations	3
• Provides some explanation of the expected result AND/OR • Includes relevant half equation	2
• Provides some relevant information	1

Sample answer:

The nails will corrode faster in acidic conditions. This is because in the presence of H^+ ions the oxygen is more easily reduced and is therefore a stronger oxidising agent because it has a more positive reduction potential.

$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$ E = 0.40 V

$O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ E = 1.23 V

Question 32 (b) (i)

Criteria	Marks
• Outlines TWO ways	2
• Outlines ONE way OR • Identifies TWO ways	1

Sample answer:

Increasing the concentration of the electrolyte will increase the rate of the reaction. A higher voltage will also increase the rate.

Question 32 (b) (ii)

Criteria	Marks
• Accounts for the observations including relevant equations	4
• Accounts for some observations and provides at least one relevant equation	3
• Identifies reason(s) for the observations AND/OR • Provides relevant equation(s)	2
• Provides some relevant information	1

Sample answer:

The bubbles at the anode were due to the oxidation of chloride ions

$$Cl^- \rightarrow \frac{1}{2} Cl_2(g) + e^-$$

The decrease in blue intensity was due to the removal of Cu^{2+} ions as they are reduced at the cathode. The solid copper produced in this reaction was deposited on the cathode and accounts for the increase in mass.

$Cu^{2+} + 2e^- \rightarrow Cu(s)$.

Question 32 (c) (i)

Criteria	Marks
• Shows why the rate of corrosion would have been slow at the depth	2
• Provides some relevant information	1

Sample answer:

Scientists thought that the rate of corrosion would be very slow because at great depths the temperature and concentration of oxygen would be low.

Question 32 (c) (ii)

Criteria	Marks
• Provides a valid explanation	2
• Provides some relevant information	1

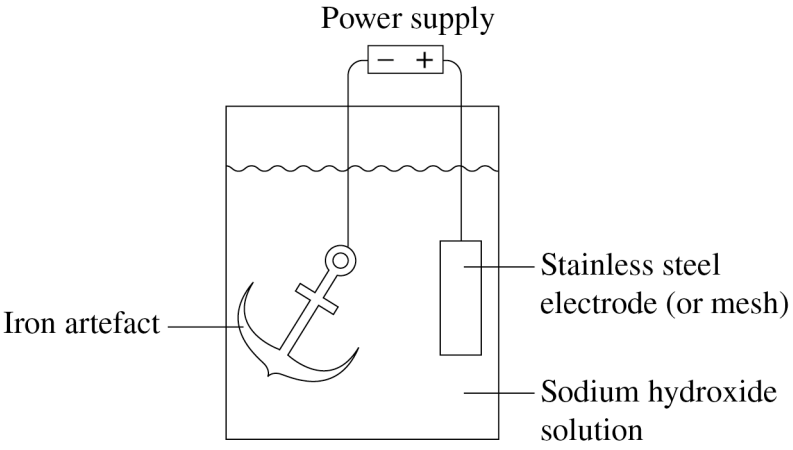
Sample answer:

The wooden artefact in seawater will be saturated with salts such as NaCl. If allowed to dry out without treatment the NaCl will crystallise within the wood and distort the structure.

Question 32 (c) (iii)

Criteria	Marks
• Describes how electrolysis can be used to remove chloride ions • Includes a relevant labelled diagram	3
• Outlines how electrolysis can be used to remove ions AND/OR • Includes a diagram	2
• Identifies a feature of electrolysis	1

Sample answer:



The artefact is submerged in a dilute NaOH electrolyte. The artefact functions as a cathode as it is attached to the negative terminal of a DC power source. The positive terminal is attached to a stainless steel anode. The negatively charged chloride ions migrate away from the artefact towards the positively charged anode.

Question 32 (d)

Criteria	Marks
• Describes the relevant work of Volta and Davy and their influence on reducing corrosion of ocean-going vessels • Draws out and relates implications	7
• Describes the relevant work of Volta and Davy • Relates the work to reducing corrosion of ocean-going vessels	6
• Outlines the relevant work of Volta and/or Davy • Links this work to reducing corrosion of ocean-going vessels	4–5
• Shows some understanding of the work of Volta and/or the work of Davy and/or reducing corrosion of ocean-going vessels	2–3
• Provides some relevant information	1

Sample answer:

Both Volta and Davy contributed significantly to our understanding of electron transfer reactions, leading to an increase in the range of metals and an understanding of how to protect metals from corrosion.

Volta disproved Galvani's ideas and showed that the electricity was due to the two different metals in contact with the frog's legs. He went on to show that the greater the difference in the reactivity of the metal, the greater the electricity. Volta also developed his voltaic pile that was the first practical source of DC current. Davy used this source to carry out various electrolysis experiments and actually investigated the process of corrosion.

Using Volta's idea that the current was linked to the difference in reactivity of the metals, Davy experimented with the idea of sacrificial protection, a method that is still used today. This involves attaching a more active metal like zinc to the iron hull of a ship. The zinc undergoes oxidation instead of the iron, thus protecting it from corrosion.

Davy's electrolysis experiments also allowed for the extraction of new metals from their compounds. This has led to a greater range of metals like aluminium and chromium being available for shipbuilding. Small boats are made out of aluminium that is a passivating metal that resists corrosion, while chromium is alloyed with iron to produce stainless steel that is used in various components, as they are corrosion resistant.

The increased understanding of electrolysis reactions stemming from Davy's work has led to the use of cathodic protection to prevent the corrosion of ships' hulls. This process involves connecting the iron hull of a ship to the negative terminal of a DC power supply while the positive terminal is connected to an inert electrode. This prevents the formation of Fe^{2+} ions by reducing them back to Fe(*s*).

These and other processes would not be available without our understanding of electron transfer reactions, which have stemmed from the work of Volta and Davy.

Question 33 (a) (i)

Criteria	Marks
• Provides a valid explanation	2
• Provides some relevant information	1

Sample answer:

The enzyme optimally functions at pH 2–4.

Since pH affects structural confirmation, at pH 9 the enzyme may not have the correct structure and therefore will not be optimally functional.

Question 33 (a) (ii)

Criteria	Marks
• Describes a suitable procedure	3
• Outlines some relevant steps	2
• Provides some relevant information	1

Sample answer:

1. Water baths were prepared at temperatures of 20°C, 30°C, 40°C and 50°C.
2. 3 mL of milk was added to 8 test tubes using a pipette. Test tubes placed in water bath until temperature was reached.
3. 5 drops of junket mix was added to each test tube.
4. Test tubes were mixed by shaking and then carefully examined for clotting.
5. The time taken to clot was recorded and enzyme activity calculated.

Question 33 (b) (i)

Criteria	Marks
• Outlines how the structure of ATP gives rise to energy production	2
• Provides some relevant information	1

Sample answer:

ATP has an adenosine core with three phosphate groups attached. The hydrolysis of a phosphate group converting ATP to ADP is highly exothermic releasing energy for cellular processes.

Question 33 (b) (ii)

Criteria	Marks
• Correctly calculates time for contraction	4
• Provides substantially correct working	3
• Provides some relevant steps	2
• Provides ONE relevant step	1

Sample answer:

$$\text{mols per g} = \frac{4 \times 10^{-3}}{1.2 \times 10^{3}} \text{mol g}^{-1}$$

$$= 3.3 \times 10^{-6} \text{mol g}^{-1}$$

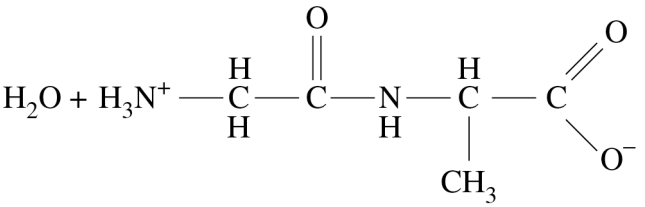
ATP consumed
$3.3 \times 10^{-6} / 1 \times 10^{-3}$

$= 3.3 \times 10^{-3}$ minutes
$= 0.198$ seconds ≈ 0.2 seconds

Question 33 (c) (i)

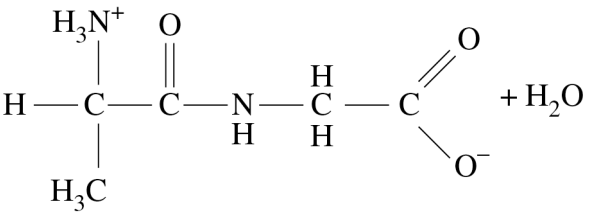
Criteria	Marks
• Provides correct structural formula including water molecule	2
• Provides substantially correct structural formula OR • Identifies a product	1

Sample answer:



Gly-Ala

Answers could include:



Ala-Gly

Question 33 (c) (ii)

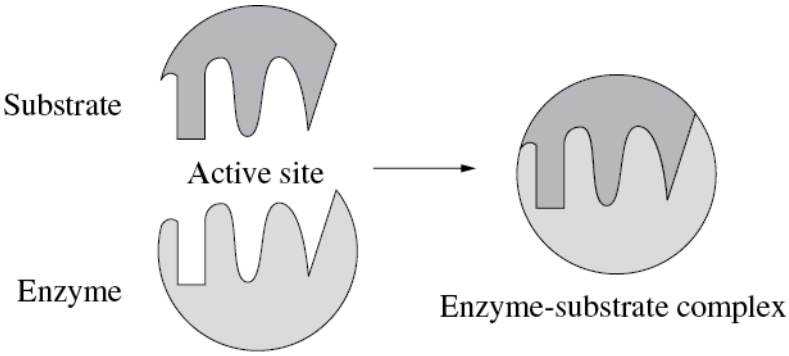
Criteria	Marks
• Provides an explanation using a suitable model	3
• Shows some understanding of why enzymes are specific to their substrate	2
• Provides some relevant information	1

Sample answer:

Lock and key model

For a substrate to bind to an enzyme bonds must form between the active site of the enzyme and the substrate. The active site is located within the protein structure of the enzyme. If an incorrect enzyme comes into contact with the substrate it will not bind as these bonds will not form.

The lock and key model explains the need for the precise fit and a complementary substrate/enzyme complex. It is similar to a lock and key whereby the key must fit a particular lock.



Lock and key Model – the substrate and enzyme active site have complementary shapes

Answers could include:

The induced fit model is a more recent idea whereby the substrates change their shape slightly and become bound to the enzymes by weak chemical bonds. This binding can weaken the bonds within the reactants themselves, allowing the reaction to proceed more readily. Following the reaction the enzyme returns to its original shape ready to undergo another reaction.

Question 33 (c) (iii)

Criteria	Marks
• Outlines limitations of model used	2
• Outlines ONE limitation OR • Identifies limitations	1

Sample answer:

The model lacks details, especially dynamic changes in structure. Parts of the model may not be in proportion to real structures.

Question 33 (d)

Criteria	Marks
• Describes the β-oxidation pathway with reference to the breakdown of fatty acids to acetyl CoA • Relates β-oxidation and TCA cycle to ATP production	7
• Describes the β-oxidation pathway with reference to the breakdown of fatty acids to acetyl CoA • Links β-oxidation to ATP production	6
• Outlines the β-oxidation pathway • Shows some link between B-oxidation and ATP production	4–5
• Shows some understanding of long chain fatty acids and/or the production of usable energy	2–3
• Provides some relevant information	1

Sample answer:

A long chain fatty acid is a carboxyl group with a backbone of carbon and hydrogen attached. Fats provide more ATP per gram than carbohydrates.

Fatty acids are obtained from the breakdown of Triacylglycerides (TAGs) into glycerol and fatty acids. These fatty acids are converted to an activated fatty acyl-CoA.

β-oxidation then results in the production of acetyl-CoA, 1 $FADH_2$, 1 NADH and another fatty acyl-CoA molecule, 2 carbon atoms shorter than the original. This process is repeated until the full acyl chain has been oxidised into acetyl-CoA (eg palmitoyl CoA (16 carbon chain) will give 8 acetyl CoA molecules).

Each acetyl-CoA is then fed into the tricarboxylic acid cycle (TCA) to produce 1 ATP, 3 NADH and 1 $FADH_2$. The NADH and $FADH_2$ from both β-oxidation and the TCA cycle then goes to oxidative phosphorylation to produce more ATP (NADH = 3ATP; $FADH_2$ = 2ATP).

Question 34 (a) (i)

Criteria	Marks
• Outlines a suitable test and includes a relevant safety precaution	2
• Provides some relevant information	1

Sample answer:

- Ignite flame of a Bunsen burner on a heat-proof mat.
- Spray into flame one at a time low-concentration aqueous nitrate salts of metal ions eg calcium.
- Ensure that salts are not sprayed towards others.
- Observe and record resulting flame colour.

Question 34 (a) (ii)

Criteria	Marks
• Accounts for the flame colour observed	3
• Shows some understanding of energy levels and/or visible spectrum	2
• Provides some relevant information	1

Sample answer:

For example calcium ions in a flame emit a brick red colour.
In the Bohr model of the atom, electrons orbit the nucleus in circular orbits, which are associated with different energy levels. When calcium ions are sprayed into a flame, the cations absorb heat from the flame. If the quantity of heat absorbed equals the energy difference between two energy levels within the ion, an electron can become excited and moves to a higher energy level. When an electron in an excited state drops to a lower energy level, it emits a photon of a discrete frequency that equals the energy difference between the two energy levels. Therefore discrete wavelengths of light are emitted and if these are in the visible spectrum, as in the case of calcium, they will be seen as colour.

Question 34 (b) (i)

Criteria	Marks
• Outlines the two main components of paint	2
• Outlines one component of paint	1

Sample answer:

Paints are comprised of a pigment, which provides colour, and a liquid medium to carry the pigment and spread it over the surface.

Question 34 (b) (ii)

Criteria	Marks
• Identifies a colour used by Aboriginal peoples and a metal ion as the chemical component responsible for the colour • Provides a thorough explanation of why transition metal ions appear coloured	4
• Identifies a colour used by Aboriginal peoples and a metal ion as the chemical component responsible for the colour • Provides a basic explanation of why transition metal ions appear coloured	3
• Relates specific colour to a naturally occurring chemical compound • Identifies transition metal ion as responsible for the colour	2
• Provides some relevant information	1

Sample answer:

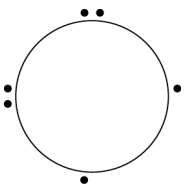
Red was one of the colours used by Aboriginal peoples. The reds are ochres formed from silica or clay. Red ochre contains anhydrous iron (III) oxide (Fe_2O_3), which is responsible for the colour. The iron is one of the transition metals on the Periodic Table due to its electron configuration of incompletely filled 3*d* orbitals. These *d* orbitals have slightly different energies, the differences between them being similar to the energies of visible light enabling the electrons in transition metal ions to jump to a slightly higher-energy *d* orbital by absorbing photons of white light. This causes the compound to appear coloured.

Question 34 (c) (i)

Criteria	Marks
• Identifies the error and justifies the answer using Hund's rule	3
• Identifies the error and/or shows some understanding of Hund's rule	2
• Identifies the error OR • Shows a basic understanding of Hund's rule	1

Sample answer:

The diagram should be drawn as shown with all four available suborbitals being used.



This is because Hund's rule states that orbitals of equal energy (such as the 2p orbitals) each acquire one electron before any orbital acquires two electrons. In the original diagram the paired dots suggest two of the p-orbitals contained two electrons while the third contained none. A better representation would be a pair in one 2p orbital and a single electron in each of the other 2p orbitals represented by single dots.

Question 34 (c) (ii)

Criteria	Marks
• Provides a valid explanation	2
• Provides some relevant information	1

Sample answer:

The energy required to promote an electron from its outer shell from Sc^{3+} to Sc^{4+} is significantly higher than that required from Sc^{2+} to Sc^{3+} or from Sc^{+} to Sc^{2+}.

Question 34 (c) (iii)

Criteria	Marks
• Provides a valid explanation	2
• Provides some relevant information	1

Sample answer:

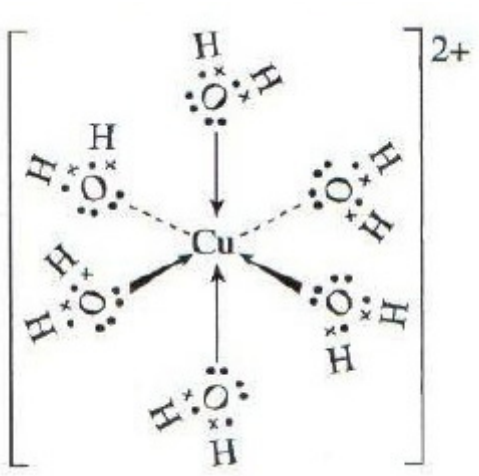
From the graph, a much higher amount of energy is needed for Sc^{3+} than for V^{3+} to promote an electron from its outer shell. The amount of energy required by Sc^{3+} would require a frequency outside the visible spectrum while the energy required by V^{3+} would be within the visible spectrum.

Question 34 (d)

Criteria	Marks
• Provides an example of a complex ion of a transition metal • Using the example to explain the bonding is complex ions of transition metals	7
• Provides an example of a complex ion of a transition metal • Describes the bonding in the complex ion • Provides some explanation of the bonding	6
• Provides an example of a complex ion of a transition metal • Outlines features of the bonding in the complex ion	4–5
• Provides an example of a complex ion of a transition metal AND/OR • Identifies feature(s) of the bonding in complex ions of transition metals	2–3
• Provides some relevant information	1

Sample answer:

A complex ion of a transition metal has the metal cation surrounded by anions or polar molecules referred to as ligands. Examples of ligands include chloride, cyanide and polar molecules such as water and ammonia. Ligands have at least one atom with a lone pair of unbonded electrons. Coordinate covalent bonds form between the ligands and the transition metal ion using the electron lone pairs on the ligands. Hydrated metal ions are examples of complex ions, such as copper (II) hexahydrate ion $[Cu(H_2O)_6]^{2+}$.



This ion can form when an ionic solid such as copper sulfate dissolves in water. The ions dissociate and are surrounded by polar water molecules with two pairs of unshared electrons. Because the negatively charged side of the water molecule, the oxygen atom, is attracted to the cation, the lone pairs of electrons can be shared with the cation in a coordinate covalent bond. Ligands which bond using the electron pair of a single donor atom such as the oxygen atom in H_2O forming $[Cu(H_2O)_6]^{2+}$ are ligands. If more than one atom of the ligand can donate an electron pair and the ligand monodentate bonds to the cation through more than one pair, the ligand is known as polydentate. Polydentate ligands bind more tightly to the metal ion than monodentate ligands.

Question 35 (a) (i)

Criteria	Marks
• Outlines a suitable test	2
• Provides some relevant information	1

Sample answer:

Add a few drops of acid to the sample. If bubbles appear, it is sodium carbonate.

Question 35 (a) (ii)

Criteria	Marks
• Provides a valid explanation with reference to atomic structure	3
• Shows some understanding of how the lines are produced	2
• Provides some relevant information	1

Sample answer:

When an atom is heated, electrons are exited into higher energy levels. As the electrons return to lower energy levels, they emit light energy at certain wavelengths, characteristic to the element. These emissions are seen as coloured lines in an emission spectrum.

Question 35 (b) (i)

Criteria	Marks
• Provides a valid explanation	2
• Provides some relevant information	1

Sample answer:

A pencil contains insoluble graphite whereas a pen may contain soluble pigments. Soluble pigments from the pen may move with the solvent, blurring or moving the starting line. Therefore a pencil line is better as it will remain in place as a reference line.

Question 35 (b) (ii)

Criteria	Marks
• Justifies a suitable modification	4
• Shows some understanding of solvent choice and separation AND/OR • Outlines a suitable modification	2–3
• Provides some relevant information	1

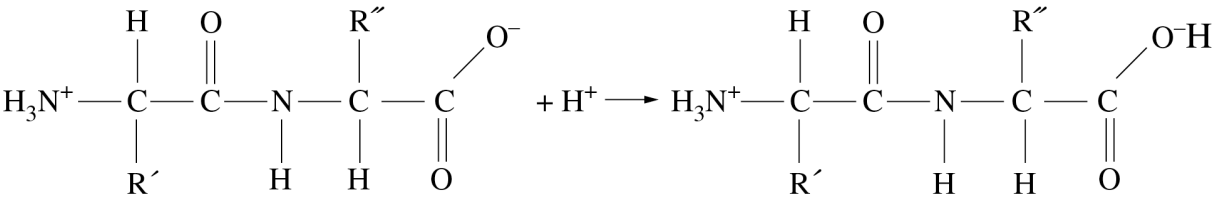
Sample answer:

The student should repeat the experiment using a polar solvent as the mobile phase. An alkane is a non-polar solvent and the alkanol and alkanoic acid are both polar substances. As like dissolves like, a polar solvent will cause the polar substances to move up the stationary phase. As alkanoic acids tend to be more polar than alkanols of similar chain length, the alkanoic acid will move further up the stationary phase than the alkanol thus separating them.

Question 35 (c) (i)

Criteria	Marks
• Draws a correct equation	2
• Provides some relevant information	1

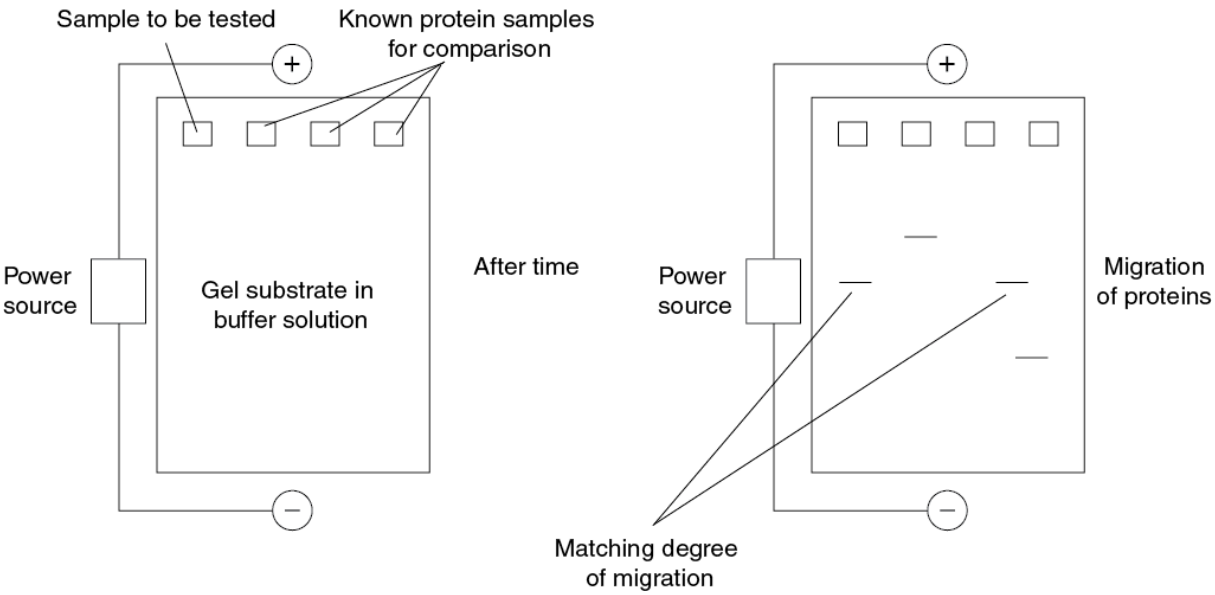
Sample answer:



Question 35 (c) (ii)

Criteria	Marks
• Explains how electrophoresis is used to separate and identify proteins • Includes a detailed labelled diagram	3
• Outlines how electrophoresis is used to separate and/or identify proteins	2
• Provides some relevant information	1

Sample answer:



Proteins can be identified using electrophoresis. The protein to be tested and samples of known proteins are loaded in a well of the gel substrate. An electric current is passed through the gel matrix and the proteins migrate towards the negative terminal, according to their size. The migration of the unknown sample is then matched to the migration of the known samples so that it can be identified.

Question 35 (c) (iii)

Criteria	Marks
• Identifies the TWO correct substances with justification	2
• Identifies correct substances OR • Identifies ONE correct substance with justification	1

Sample answer:

Heroin and ethanol. The major peaks in the heroin and ethanol mass spectrometry samples coincide with the peaks in the spectrum obtained from the analysis of the blood sample.

Question 35 (d)

Criteria	Marks
• Provides a thorough discussion on the use of DNA analysis in finding lost relatives • Shows a thorough understanding of DNA analysis • Includes the relevant underlying chemistry	7
• Provides some discussion on the use of DNA analysis in finding lost relatives • Shows a sound understanding of DNA analysis • Includes relevant underlying chemistry	6
• Outlines issues associated with DNA analysis AND/OR • Includes some relevant chemistry	4–5
• Shows some understanding of DNA analysis	2–3
• Provides some relevant information	1

Sample answer:

DNA is a large polymer molecule that codes genetic information for the transmission of inherited traits. Sections of DNA called gene code for specific inherited characteristic and these are found in the part of the DNA referred to as the exons which are very similar between individuals. The non-coding parts of the DNA are called introns and these differ widely between individuals due to the different lengths of short tandem repeats within these sections.

When DNA is analysed, restriction enzymes are used to cut the DNA into fragments. These fragments are separated and ordered by gel electrophoresis to produce a sequence that is unique to the individual. The introns are identified by using probes complimentary to the short tandem repeats. The result is a series of bands on the gel. This is called a DNA profile.

Children inherit 50% of their introns from their mother and 50% from their father so parts of an individual's profile will show similarities to relatives. The number of similarities can provide a very accurate indication of the relationship between these family members. It is therefore a very accurate method for providing paternity or that people are related. However, the DNA of both parties needs to be available for this to work. Either both parties must agree to providing DNA samples or a DNA databank must be searched.

These concerns about the violation of privacy and human rights with respect to the maintenance of DNA data banks. Privacy and security of DNA data banks are a concern as DNA profiles can be stored indefinitely and potentially be used in the future for new and unidentified purposes. Laws could also change to allow that profile to be shared with others.

In instances eg terrorist bombings where bodies are largely destroyed, this analysis can be extremely useful to identify the victims as only a small amount of their DNA is required and can be compared to the DNA of family members to establish their identity very accurately.

2017 HSC Chemistry
Mapping Grid

Section I
Part A

Question	Marks	Content	Syllabus outcomes
1	1	9.3.4.3.3	H11.3 (a)
2	1	9.4.3.3.1	H6
3	1	9.4.4.2.9	H9
4	1	9.3.5.3.1	H11.2 (e)
5	1	9.3.4.2.6	H8
6	1	9.2.5.2.2	H6
7	1	9.2.1.3.2	H9, H13
8	1	9.4.3.2.1, 9.4.3.3.1	H8
9	1	9.2.3.3.6, 9.4.1.2.3	H9, H10, H14
10	1	9.2.4.3.3	H3, H7
11	1	9.2.4.2.3	H6, H8
12	1	9.2.1.3.3, 9.2.1.2.5	H9
13	1	9.3.3.2.2, 9.3.4.3.3	H10
14	1	9.3.4.2.9, 9.3.4.2.3	H8
15	1	9.4.4.2.4, 9.4.4.2.5	H6
16	1	9.3.2.2.4, 9.3.2.2.5	H8
17	1	9.3.2.2.9, 9.4.4.2.6	H10, H12.4 (b)
18	1	9.3.2.2.4, 9.4.2.2.9	H10
19	1	9.4.3.3.3	H10, H12.4 (b)
20	1	9.3.3.3.7, 9.3.3.2.5	H10, H12.4 (b)

Section I
Part B

Question	Marks	Content	Syllabus outcomes
21 (a)	2	9.4.4.2.3	H4
21 (b)	2	9.4.4.2.6	H8
21 (c)	1	9.4.4.3.1	H6
22 (a)	3	9.4.3.3.5	H13.1 (f)
22 (b)	2	9.4.5.2.1, 9.4.3.3.5	H12.4 (b), H4
23 (a)	2	9.2.4.3.1, 9.2.4.2.5	H7
23 (b)	4	9.2.4.2.2, 9.2.4.2.4, 9.2.4.2.6	H7, H10, H12.4 (b)
24 (a)	3	9.3.4.3.3	H12.4 (b), H10
24 (b)	2	9.3.4.2.4, 9.2.1.3.1, 9.2.1.2.1	H8
25	4	9.2.2.2.5, 9.2.3.3.5, 9.2.3.3.1, 9.2.1.2.6	H1, H5
26 (a)	3	9.3.2.2.6, 9.3.2.2.7, 9.3.2.2.8, 9.3.2.2.10, 9.3.2.3.2	H4, H8, H14.1, H14.3

Question	Marks	Content	Syllabus outcomes
26 (b)	4	9.3.2.1	H8, H4, H14.1, H14.3
27	5	9.3.5.2.1, 9.3.5.2.3	H9, H2, H14
28 (a)	4	9.2.3.2.4, 9.2.3.2.8, 9.2.3.3.3	H9, H4, H5
28 (b)	3	9.2.3.3.6	H7, H9, H10, H12.4 (b)
29	4	9.4.5.1	H4, H12.3 (c), H14.1
30	7	9.4.2.1	H1, H2, H8, H10, H14.1

Section II

Question	Marks	Content	Syllabus outcomes
Question 31		**Industrial Chemistry**	
(a) (i)	2	9.5.5.2.1	H9
(a) (ii)	3	9.5.5.3.1	H9, H11
(b) (i)	2	9.5.3.2.4, 9.5.3.2.5	H8
(b) (ii)	4	9.5.2.2.3, 9.5.2.3.4, 9.5.3.2.5	H8
(c) (i)	2	9.5.6.2.3	H3, H4
(c) (ii)	2	9.5.6.2.3	H3, H8
(c) (iii)	3	9.5.6.2.3	H3, H8
(d)	7	9.5.4.2.3	H3, H5
Question 32		**Shipwrecks, Corrosion and Conservation**	
(a) (i)	2	9.6.6.3.1	H11.3 (a)
(a) (ii)	3	9.6.6.2.3	H8
(b) (i)	2	9.6.3.2.2	H8
(b) (ii)	4	9.6.3.2.1	H6, H7
(c) (i)	2	9.6.5.3.2, 9.6.5.2.4	H1, H8
(c) (ii)	2	9.6.7.2.2	H4
(c) (iii)	3	9.6.7.2.3, 9.6.7.2.5	H4
(d)	7	9.6.1.2.4, 9.6.1.3.1, 9.6.4.2.3, 9.6.4.3.4, 9.6.4.2.1,	H1, H3
Question 33		**The Biochemistry of Movement**	
(a) (i)	2	9.7.4.3.2, 9.7.4.2.5, 9.7.4.2.6	H2, H8
(a) (ii)	3	9.7.4.3.2	H11
(b) (i)	2	9.7.1.1	H9
(b) (ii)	4	9.7.1.2.1	H10, H12.4 (b)
(c) (i)	2	9.7.4.2.3	H9, H10, H13.1d
(c) (ii)	3	9.7.4.2.7, 9.7.4.3.3	H2, H8
(c) (iii)	2	9.7.4.3.3	H2
(d)	7	9.7.6.1, 9.7.1.2.4, 9.7.8.2.1-3	H7, H9, H10
Question 34		**The Chemistry of Art**	
(a) (i)	2	9.8.2.3.1	H11

Question	Marks	Content	Syllabus outcomes
(a) (ii)	3	9.8.2.2.1, 9.8.2.2.2, 9.8.2.2.3, 9.8.2.2.2.7, 9.8.2.3.1	H2
(b) (i)	2	9.8.1.2.6	H4
(b) (ii)	4	9.8.1.3.1, 9.8.1.2.8	H6
(c) (i)	3	9.8.3.3.2	H1, H6
(c) (ii)	2	9.8.3.2.8, 9.8.3.3.1	H6
(c) (iii)	2	9.8.2.2.4	H6
(d)	7		
Question 35		**Forensic Chemistry**	
(a) (i)	2	9.9.1.3.3	H8
(a) (ii)	3	9.9.6.2.1, 9.9.6.2.2, 9.9.6.2.3, 9.9.6.2.4	H6, H14.1
(b) (i)	2	9.9.3.3.3, 9.9.3.3.4	H11.2 (d), H11.2 (e)
(b) (ii)	4	9.9.3.3.3, 9.9.3.3.4	H11.2 (d), H11.2 (e)
(c) (i)	2	9.9.3.2.3	H9
(c) (ii)	3	9.9.3.2.6, 9.9.3.3.5	H11
(c) (iii)	2	9.9.5.2.3, 9.9.5.3.1	H12.3 (c), H14
(d)	7	9.9.1.3.2, 9.9.4.3.1, 9.9.4.2.2, 9.9.4.2.3	H1, H3, H4, H14