CATHOLIC SECONDARY SCHOOLS ASSOCIATION

2002 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

CHEMISTRY MARKING GUIDELINES

Section I
Part A
Questions 1-15 (1 mark each)

Question	Correct Response	Outcomes
1	C	H8, H9
2	A	H9
3	C	H8
4	D	H6
5	C	H7
6	B	H12
7	B	H8
8	C	H11

Question	Correct Response	Outcomes
9	A	H6
10	D	H10, H12, H14
11	B	H11
12	A	H12
13	B	H6
14	D	H8
15	B	H6

Section I
Part B (Total marks 60)

Question 16 (5 marks)
(a) (1 mark)
Outcomes Assessed: H4, H9
Targeted Performance Bands: 2-3

Criteria	Marks
• Correct response of chloroethene	1

(b) (2 marks)
Outcome Assessed: H4
Targeted Performance Bands: 3-4

Criteria	Marks
• Identifies use and relates to physical property	2
• Identifies a correct use OR • Identifies a property of the plastic	1

Sample Answer:
PVC is used in underground piping. It is useful because PVC is stiffer than polyethene because of the Cl side chain. It is best used underground because the Cl side chain makes it susceptible to weakening in the presence of UV-light.

2801- 2

(c) (2 marks)
Outcomes Assessed: H4, H9, H14
Targeted Performance Bands: 2-4

Criteria	Marks
• Clearly establishes link between plastics being made from ethene/ethene derivatives and the source of ethene being fossil fuels eg crude oil	2
• Identifies plastics as polymers based on hydrocarbons OR • Identifies plastics as coming from fossil fuels	1

Sample Answer:
Many plastics are based on the polymerisation of ethene or monomers based on ethene eg chloroethene. The major source of ethene is crude oil ie a fossil fuel. By recycling plastics we reduce the use of ethene and hence fossil fuels.

Question 17 (a) (1 mark)
Outcome Assessed: H11
Targeted Performance Bands: 2-3

Criteria	Marks
• Correctly identifies hazard	1

Sample Answer:
The concentrated sulfuric acid is extremely corrosive to skin, clothing and eyes

(b) (2 marks)
Outcome Assessed: H12
Targeted Performance Bands: 2-3

Criteria	Marks
• Correctly identifies a safety precaution related to the chosen hazard	2
• Correctly identifies a safety precaution	1

Sample Answer:
Use a dropper to administer the concentrated sulfuric acid, since it is less likely that a spill will occur and only small quantities are added.

(c) (3 marks)
Outcome Assessed: H14
Targeted Performance Bands: 3-6

Criteria	Marks
• Identifies that the results do not demonstrate the breakdown of cellulose in wood AND • Explains that the reaction of the negative control sample (untreated wood) to iodine did not allow the decomposed cellulose products to be identified, since wood already contains substances that react with iodine	3
• Explains that the results for treated and untreated wood were the same AND • Identifies that the results do not demonstrate the breakdown of cellulose in wood	2
• Explains that the results for treated and untreated wood were the same OR • Identifies that the results do not demonstrate the breakdown of cellulose	1

Question 18 (3 marks)
Outcome Assessed: H4
Targeted Performance Bands: 3-4

Criteria	Marks
• Describes process	3
• Outlines process	2
• Identifies the use of a reactor	1

Sample Answer:
In this example, salt containing non-radioactive sodium-23 would be taken to a nuclear reactor such as the one at Lucas Heights in Sydney and placed in the core of the reactor. It is then bombarded with neutrons. When a sodium-23 atom gains a neutron to form sodium-24, the nucleus becomes unstable and emits beta particles.

Question 19 (6 marks)
Outcomes Assessed: H2, H14
Targeted Performance Bands: 2-6

Criteria	Marks
• Discusses advantages AND disadvantages, using examples	5 – 6
• Discusses advantages OR disadvantages, using examples OR • Discusses advantages AND disadvantages, WITHOUT examples OR • Identifies advantages AND disadvantages, using examples	3 – 4
• Identifies advantages OR • Identifies disadvantages OR • Gives examples of models used in chemistry	1 – 2

Sample Answer:
Models can be used to show how monomers are linked to form polymers, they can be used to simulate the movement of the electrons during bond-breaking and bond-forming or the movement of protons during acid-base reactions particularly to distinguish between the ionisation of strong and weak acids. Models also give an indication of which atoms are joined to which and the general shape of the molecule is understood, to help in the understanding of isomers. They are used to visualise what is happening at the atomic or sub-atomic level. Models, however, are not to scale so they can only be used to give general ideas, not accurately measured information.

Question 20 (6 marks)
Outcome Assessed: H11
Targeted Performance Bands: 2-5

Criteria	Marks
• Distinguishes between destructive AND non-destructive procedures, with reference to bromothymol blue and the pH meter AND • Identifies the different results AND links them to the accuracy of the technique AND the strength of the acid	5 – 6
• Defines destructive AND non-destructive without examples OR • Defines destructive OR non-destructive with examples AND • Identifies different results AND links them to the accuracy of the technique OR the strength of the acid	3 – 4
• Defines destructive OR non-destructive AND • Identifies results using one of the testing procedures	1 – 2

Sample Answer:
Using bromothymol blue is a destructive testing method since once the indicator has been added to the test solution (the acid), it cannot be removed to return the solution to its original "state". The pH meter does not change the test solution, however, it allows for the collection of data. The bromothymol blue will give the same colour (yellow) in both solutions since they would both have pHs < 6.5 thus, they cannot be distinguished using this indicator. The pH meter is more sensitive and since HCl is a strong acid and acetic acid is a weak acid, the pH meter will record different readings for each acid – HCl ~ 1 and CH_3COOH >2.

Question 21 (4 marks)
Outcomes Assessed: H1, H2, H13
Targeted Performance Bands: 3-6

Criteria	Marks
• Explains amphiprotic behaviour using correct equations to illustrate OR • Provides two net ionic equations showing bicarbonate reacting with an acid and with a base	4
• Constructs one correct equation AND identifies that bicarbonate ion is capable of donating or gaining a proton OR • Constructs two equations showing amphiprotic behaviour but includes spectator ions	3
• Constructs one correct equation involving sodium bicarbonate or bicarbonate ions with either an acid or a base	2
• Defines amphiprotic	1

Sample answer:
In water, sodium hydrogen carbonate dissociates to produce sodium ions and hydrogen carbonate ions. The HCO_3^- ion can act as a Bronsted-Lowry acid or base because it can accept or donate a proton.

$HCO_3^-(aq) + H_3O^+(aq) \rightleftharpoons H_2CO_3(aq) + H_2O(l)$ in acidic solution

$HCO_3^-(aq) + OH^-(aq) \rightleftharpoons CO_3^{2-}(aq) + H_2O(l)$ in basic solution

Substances which can both donate and accept protons are called amphiprotic.

Question 22 (a) (3 marks)
Outcomes Assessed: H8, H14
Targeted Performance Bands: 3-5

Criteria	Marks
• Applies Le Chatelier's Principle to explain loss of CO_2	3
• Describes the effect of increasing temperature on the solubility of CO_2 and relates to observed change OR • Describes the effect of heating on the equilibrium position and relates to the observed change	2
• Outlines the effect of increasing temperature on the solubility of CO_2 OR • Outlines the effect of heating on the equilibrium position	1

Sample Answer:
As the temperature increases, the solubility of carbon dioxide decreases. This is because the solution reaction is exothermic.

$$CO_2(g) + H_2O(l) \rightleftharpoons H_2CO_3(aq)$$

According to Le Chatelier's Principle, applying heat will favour the left as the equilibrium attempts to minimise the effects of heating. The CO_2 will come out of solution and will be lost to the atmosphere as the can is no longer a closed system.

(b) (2 marks)
Outcomes Assessed: H11, H12
Targeted Performance Bands: 2-4

Criteria	Marks
• Describes a control	2
• Identifies the need for a control	1

Sample Answer:
This is not a fair test because water will be lost to the atmosphere. A control can with water or flat cola with the same volume as the original cola should be placed on the hot plate and heated at the same time. The mass difference between the cans after the experiment is the loss due to CO_2.

Question 23 (4 marks)
Outcomes Assessed: H10, H12, H14
Targeted Performance Bands: 2-5

Criteria	Marks
• Correct answer and all working shown clearly (units can be assumed)	4
• Applies n =m/M and c = n/v without considering the dilution factor or unit conversion OR • Applies n =m/M and c = n/v with an incorrect molecular weight	3
• Applies n =m/M or c = n/v without considering the dilution factor or unit conversion or with an incorrect molecular weight OR • Gives correct answer with no working	2
• Calculates molecular weight OR • Converts units OR • Calculates dilution factor (x 40)	1

Sample Answer:

Molecular mass of aspirin = $(9 \times 12) + (8 \times 1) + (4 \times 16) = 180$ g/mol
Mass of aspirin = 50 mg = 5×10^{-2} g
n = m/M = 5×10^{-2} g / 180 g/mol = 2.78×10^{-4} mol (in 25 mL sample)
The dilution factor is 40.
n = $40 \times 2.78 \times 10^{-4} = 0.0111$ mol (in original 100 mL sample)
c = n/v =0.0111 /0.1L
= 0.11 mol/L

Question 24 (a) (3 marks)
Outcomes Assessed: H3, H12
Targeted Performance Bands: 2-4

Criteria	Marks
• Identifies that diagram b is more relevant than photograph a and describes reasons for each diagram	3
• Identifies that diagram b is relevant AND outlines reasons for its relevance OR • Identifies that diagram b is relevant and photograph a is less relevant	2
• Identifies that diagram b is relevant	1

Sample Answer:

Diagram B is a typical water plant so it identifies features to look for in any local town water supply. It clearly identifies both physical and chemical processes. Therefore, it is relevant to the research task. Photograph A is less relevant because it relates to a specific water plant in England and has no detail about the chemical processes although it appears to be showing filtration.

Question 24 (b) (2 marks)
Outcomes Assessed: H3, H12
Targeted Performance Bands: 4-5

Criteria	Marks
• Identifies the need to compare to other sources AND identifies one or more of the following considerations: recency, publisher, author	2
• Identifies the need to compare to other sources OR • Identifies one or more of the following considerations: recency, publisher, author	1

Sample Answer:

To consider the reliability of the source material, you should consider the date of publication, the reputation of the publisher/author and compare the information to other sources.

Question 25 (7 marks)
Outcomes Assessed: H3, H8, H11, H12, H13
Targeted Performance Bands: 2-6

Criteria	Marks
• Justifies a procedure used to determine the nitrogen content in fertiliser AND • Includes all relevant equations AND • Identifies the assumptions made in the methodology	6 – 7
• Describes a procedure used to determine the nitrogen content in fertiliser AND • Includes at least one relevant equation OR • Identifies an assumption made in the methodology	4 – 5
• Describes a procedure used to determine the nitrogen content in fertiliser OR • Includes at least one relevant equation	2 – 3
• Identifies that titration is the technique used OR • Identifies ONE assumption made in methodology	1

Sample Answer:
A known mass of fertiliser is added to water then a known number of moles (in excess) of NaOH is added to the fertiliser solution. The reaction is:

$$NH_4^+ + OH^- \rightarrow H_2O(l) + NH_3(g)$$

It is assumed that all of the nitrogen in the fertiliser is present as ammonium and it all reacts with the sodium hydroxide. This solution is then titrated against standardised HCl. The excess NaOH reacts with the HCl according to the equation below:

$$H^+ + OH^- \rightarrow H_2O(l)$$

Thus, the quantity of nitrogen in the fertiliser can be determined:
n (N) = n (NH_4^+) = n (NaOH reacted with NH_4^+) = n (total NaOH) – n (NaOH reacted with HCl)

Question 26 (6 marks)
Outcomes Assessed: H3, H6, H7, H8, H10, H13
Targeted Performance Bands: 2-6

Criteria	Mark
• Assesses the significance of ammonia production to society, relating it to world events at the time the process was developed AND • Provides a balanced chemical equation for the Haber process	6
• Identifies the significance of ammonia production to society AND • Provides a balanced chemical equation for the Haber process	4-5
• Describes some uses of ammonia	2-3
• Identifies ammonia as the product of the Haber process	1

Sample Answer:
The Haber process produces ammonia from nitrogen and hydrogen, as shown in the equation below.

$$N_2(g) + 3\,H_2(g) \rightleftharpoons 2\,NH_3(g)$$

Ammonia is used in the production of fertilisers and explosives. At the beginning of the 1900s, the world's population was increasing. There was a need to develop an industrial process to produce ammonia since the natural supplies of nitrogen based compounds were in short supply. The ammonia would be used to fertilise crops to produce food for the world's increased population. It was also a militarily unstable time, thus countries felt that they needed to develop and stockpile explosives for defence purposes. The industrial production of ammonia was successfully developed by a German and hence enhanced the German war efforts of 1914, since they were no longer dependent on importing nitrogen-based compounds from abroad.

Question 27 (3 marks)
Outcomes Assessed: H9, H13
Targeted Performance Bands: 2-5

Criteria	Mark
• Explains why CFCs can destroy ozone whilst HFCs do not (identifying the role of chlorine in the destruction of ozone) AND • Describes an effect of ozone destruction on living things	3
• Describes the beneficial role that ozone plays in the stratosphere	2
• Identifies that CFCs destroy ozone OR • HFCs do not destroy ozone	1

Sample Answer:
Ozone (O_3) in the stratosphere absorbs the harmful UV radiation from the Sun, namely UV-b and some UV-c. Depletion of the ozone layer allows some of these harmful UV-rays to reach the Earth's surface. CFCs diffuse through the atmosphere to the stratosphere. They contain chlorine atoms that react with the ozone to break it down to oxygen (O_2), reforming the chlorine atom so that the destruction process can continue. HFCs can be used for the same purposes as CFCs, however, they do not contain chlorine so they do not react with ozone.

Option – Industrial Chemistry

Question 28 (a) (i) (1 mark)
Outcome Assessed: H8
Targeted Performance Bands: 2-3

Criteria	Marks
• Correctly identifies the raw materials as brine (sodium chloride) AND limestone (calcium carbonate)	1

(a) (ii) (2 marks)
Outcomes Assessed: H3, H8
Targeted Performance Bands: 2-4

Criteria	Marks
• Describes a current use of sodium carbonate	2
• States a current use of sodium carbonate	1

Sample Answer:
Glass making – sodium carbonate along with sand and limestone is used in making glass.
(b) (5 marks)
Outcomes Assessed: H3, H7, H8
Targeted Performance Bands: 2-6

Criteria	Marks
• Correctly identifies the products for both and gives an explanation for both that includes reference to standard reduction potentials	5
• Correctly identifies the products but does not refer to potentials in explanation OR • Refer to potentials and identifies some of the products only	4
• States the products correctly but does not explain their answer OR • States and explains the products for either molten OR aqueous NaCl	3
• States two products correctly OR • Explains how one product is formed	2
• States a product or writes a relevant equation and associated standard potential	1

Sample Answer:

Cathode	$Na^+ + e^- \rightarrow Na_{(s)}$	- 2.71V
Anode	$Cl^- \rightarrow \frac{1}{2} Cl_{2(g)} + e^-$	-1.36V

Molten NaCl electrolysis products -sodium metal and chlorine gas

Cathode	$Na^+ + e^- \rightarrow Na_{(s)}$	-2.71V
	$H_2O + e^- \rightarrow \frac{1}{2} H_{2(g)} + OH^-$	- 0.83V
Anode	$Cl^- \rightarrow \frac{1}{2} Cl_{2(aq)} + e^-$	-1.40V
	$H_2O \rightarrow \frac{1}{2}O_{2(g)} + 2H^+ + 2e^-$	-1.23V

When water is present, there are two more possible reactions. Depending on concentration, different products are formed ie hydrogen at the cathode and chlorine at the anode or for a very dilute solution, oxygen at the anode.

(c) (i) (1 mark)
Outcomes Assessed: H8, H10
Targeted Performance Bands: 3-4

Criteria	Marks
$2SO_{2(g)} + O_{2(g)} \rightarrow 2SO_3(g)$	1

(c) (ii) (3 marks)
Outcomes Assessed: H5, H8, H12
Targeted Performance Bands: 3-5

Criteria	Marks
• Explains the effect of the catalyst, pressure and temperature with regard to rate and position of equilibrium	3
• Explains the effect of two of the three conditions with regard to rate AND position of equilibrium OR • Explains the effect of 3 factors on rate OR equilibrium	2
• Describes the effect of one factor on rate AND equilibrium OR • Describes the effect of two factors on rate OR equilibrium	1

Sample Answer:
Catalyst of vanadium oxide increases rate for the same temperature but does not affect the equilibrium
Temperature of 400→ 500°C is a compromise as forward reaction is exothermic.
Higher temperature means higher rate of reaction but at the expense of a decrease in yield of SO_3
Atmospheric pressure – higher pressure would result in higher rate and higher yield 3 → 2 moles of gas but more expensive plant not cost effective in this case

(d) (6 marks)
Outcomes Assessed: H7, H8, H12, H13
Targeted Performance Bands: 2-6

Criteria	Marks
• Thoroughly describes a method (including safety precautions) for named reaction type AND • Describes ways in which accuracy AND reliability could be improved (makes link)	5-6
• Describes a method and safety precaution, for named reaction type AND • Describes ways in which accuracy AND reliability could be improved	3-4
• Describes a first hand investigation involving sulfuric acid OR • Describes ways in which accuracy OR reliability could be improved	1-2

Sample Answer:
Oxidizing agent eg concentrated H_2SO_4 and Cu. To a dry gas jar with lid, add a few ½ cm pieces of copper wire in fume cupboard. Using rubber gloves and goggles and a clean, dry squash pipette, open concentrated H_2SO_4 and transfer quickly approximately 1 mL of concentrated H_2SO_4 to gas jar (slide on lid). Replace lid of H_2SO_4 bottle.
Cu rapidly dissolves to produce blue green solution and a gas is produced.
The reliability could be improved by cleaning the Cu wire so you don't get any side reactions and the accuracy could be improved by weighing a known amount of Cu using an electronic balance.

(e) (7 marks)

Outcomes Assessed: H1, H3, H5, H9, H13, H14

Targeted Performance Bands: 2-6

Criteria	Marks
• Analyses the trend giving examples involving the use of soap, cationic, anionic and non-ionic detergents and relates these to their properties.	6-7
• Describes three or more examples of former uses of soaps where synthetic detergents are now used OR • Relates two or more uses to the superior properties of detergents over soaps	4-5
• States two or more uses of detergents or soaps OR • Relates a use where a synthetic detergent has replaced a soap to its superior properties	2-3
• States a use of a synthetic detergent or soap	1

Sample Answer:

Soap is still used for personal hygiene.

Synthetic detergents would remove too much oil from the skin as they are more effective surfactants. They are used in cleaning products eg laundry and dishwashing detergents. Non-ionics are low foaming so are used in dishwashing powders. Cationics are used in hair conditioners and fabric softeners. Unlike soap, synthetic detergents do not form a precipitate with Mg^{2+} or Ca^{2+} ions and therefore can be used effectively in hard water. Synthetic detergents, however, are more expensive and have more environmental impact as they contain phosphate builders that cause algal blooms etc. Because of their superior surfactant qualities synthetic detergents can be used in situations where soaps would not be suitable at all eg in cosmetics, paints and adhesives.

Option – Shipwrecks and Salvage

Question 29 (a) (i) (1 mark)
Outcome Assessed: H6
Targeted Performance Bands: 2-3

Criteria	Mark
• Correct response – oxidation	1

(a) (ii) (2 marks)
Outcomes Assessed: H6, H8
Targeted Performance Bands: 3-4

Criteria	Marks
• Outlines cathodic protection AND • Gives an example of a metal that is used for cathodic protection	2
• Outlines cathodic protection OR • Gives a common example of a metal used for cathodic protection	1

Sample Answer:
Cathodic protection involves the use of a more reactive metal attached to the hull of a ship. The 'sacrificial' anode corrodes first, causing the ship's hull to become the cathode thus it is reduced not oxidised. Magnesium, zinc or aluminium are often used,

eg. $Mg(s) \rightarrow Mg^{2+}(aq) + 2e^-$

(b) (i) (2 marks)
Outcomes Assessed: H7, H8
Targeted Performance Bands: 2-4

Criteria	Marks
• Describes a procedure to clean AND preserve	2
• Describes a procedure to clean OR stabilise	1

Sample Answer:
Example: Silver items
The process involves two main stages of treatment:
- the items are soaked in a weak acid bath to remove calcium carbonate deposits
- the removal of black silver sulfide

Electrolysis can be used to reduce the black silver sulfide back to metallic silver. The hydrogen gas produced on the cathodic surface of the coin also helps to remove loose corroded particles. The restored coins can be painted with a clear lacquer to prevent further corrosion.

(b) (ii) (3 marks)
Outcomes Assessed: H4, H12, H14
Targeted Performance Bands: 3-5

Criteria	Marks
• Describes two uses of technology in the salvage of artefacts AND • Evaluates each of them	3
• Describes one use of technology in the salvage of artefacts **AND** • Evaluates it OR • Describes two uses of technology in the salvage of artefacts	2
• Identifies one use of technology in the salvage of artefacts	1

Sample Answer:
Use of X-rays to locate the position of an encrusted object, so that the removal of concretions can be done without harming the object.
Production of plastics has enabled electrolysis to be carried out in vats that won't corrode or react with acids or bases being used.
Development of resins, preservatives and lacquers has contributed to the level of restoration achieved and the prevention of further corrosion on exposure to the air.

(c) (i) (1 mark)
Outcomes Assessed: H6, H12
Targeted Performance Bands: 2-4

Criteria	Marks
• Identifies the trend, ie decreases then increases	1

(c) (ii) (3 marks)
Outcomes Assessed: H4, H6, H13
Targeted Performance Bands: 3-5

Criteria	Marks
• Thorough explanation of the decreasing oxygen concentration AND the increasing oxygen concentration	3
• Thorough explanation of the decreasing oxygen concentration OR the increasing oxygen concentration	2
• Identifies one reason for the decreasing oxygen concentration	1

Sample Answer:
At the surface there is a lot of photosynthetic organisms (producing oxygen) and a lot of wave action that mix the water and the oxygen, hence the concentrations of oxygen are large. As the depth increases, there are less photosynthetic organisms but there are still many organisms that respire, hence the oxygen is being used, but not replenished so the oxygen concentration decreases. At great depths, the water from the Arctic and Antarctic regions feeds in. This water is high in oxygen hence the oxygen concentration increases slowly.

(d) (6 marks)

Outcomes Assessed: H8, H12

Targeted Performance Bands: 2-6

Criteria	Marks
• Thoroughly describes a valid investigation AND • Describes ways in which accuracy AND reliability could be improved (makes link)	5 – 6
• Describes a valid investigation AND • Describes ways in which accuracy AND reliability could be improved	3 – 4
• Describes a valid investigation OR • Describes ways in which accuracy OR reliability could be improved	1 – 2

Sample Answer:

Place a piece of metal in separate containers with

a) distilled water
b) seawater
c) acidified seawater

Place all containers together and record observations every day for a week

The accuracy could be improved by using a pH meter to record the pHs of the solutions and the reliability could be improved by repeating the experiment at least three times to compare results

(e) (7 marks)

Outcomes Assessed: H1, H7, H13

Targeted Performance Bands: 2-6

Criteria	Marks
• Analysis of the contribution of Galvani, Davy AND Faraday in relation to electron transfer reactions	6 – 7
• Analysis of the contribution of two of Galvani, Davy and Faraday in relation to electron transfer reactions OR • Description of contributions of Galvani, Davy AND Faraday	4 – 5
• Analysis of the contribution of one of Galvani, Davy AND Faraday in relation to electron transfer reactions OR • Identifying the contribution of two of Galvani, Davy and Faraday	2 – 3
• Identifying the contribution of Galvani OR Davy OR Faraday	1

Sample Answer:

Galvani performed a series of investigations on the effect of static charge on the muscles and nerves in the legs of frogs. He also observed that the frog's legs continually twitched when the frog's spinal cord was attached to an iron railing by brass hooks. He concluded that animal tissue contained 'animal electricity'.

Davy explored applications of the Voltaic pile. He constructed the largest battery ever built and passed a strong electric current through the molten salts of various compounds (potassium hydroxide and sodium hydroxide) he suspected of containing undiscovered elements. His contribution was significant because he was able to isolate the metals potassium, sodium, strontium, calcium , magnesium and barium.

Faraday was Davy's assistant and delved into the quantitative aspects of electrochemistry. Faraday developed laws of electrolysis: that the amount of an element produced by electrolysis was dependent on the quantity of electricity passed through the circuit and the atomic weight of the element and its valency. This is important in industrial applications of electrochemistry.

Option – The Biochemistry of Movement

Question 30

(a) (i) (1 mark)

Outcome Assessed: H8

Targeted Performance Bands: 2-3

Criteria	Mark
• Correct response – water insoluble	1

(a) (ii) (2 marks)

Outcome Assessed: H9

Targeted Performance Bands: 3-4

Criteria	Marks
• Explains that molecules are largely non-polar and hence do not interact with water molecules	2
• Identifies that molecules are largely non-polar	1

(b) (5 marks)

Outcomes Assessed: H4, H7, H13

Targeted Performance Bands: 2-6

Criteria	Marks
• Identifies the different parts of the mitochondrion AND • The reactions that occur in each region AND • The significance of separating these processes.	4 – 5
• Identifies the different parts of the mitochondrion AND • The reactions that occur in some of those regions	2 – 3
• Identifies one of the reactions that occurs in a specific region of the mitochondrion	1

Sample Answer:

There are three main regions in the mitochondrion. The outer membrane allows both small molecules and small ions to move through it. The inner membrane does not allow the movement of small ions hence the matrix in the centre is isolated from other parts of the mitochondrion. The inner membrane contains the molecules for the electron transferring molecules of the respiratory chain and enzymes for the synthesis of ATP. The enzymes necessary for the TCA cycle are located in the matrix.

(c) (i) (1 mark)

Outcome Assessed: H8

Targeted Performance Bands: 2-4

Criteria	Marks
• Correct response – Release of Ca^{2+} due to nerve impulse	1

(c) (ii) (3 marks)

Outcome Assessed: H7

Targeted Performance Bands: 3-5

Criteria	Marks
• Explains why ATP is consumed during muscle contraction	3
• Describes the movement of the myosin head AND • Describes the formation of a temporary binding site	2
• Identifies that energy allows myosin head to bend OR • Identifies that energy creates environment for a temporary binding site	1

Sample Answer:

During the hydrolysis of ATP, energy is released. This energy is needed for the myosin head to bend and thus form a weak binding site with the actin in the thin filament.

(d) (6 marks)
Outcomes Assessed: H8, H9, H12
Targeted Performance Bands: 2-6

Criteria	Marks
• Thoroughly describes a valid investigation AND • Describes ways in which accuracy AND reliability could be improved (makes link)	5 – 6
• Describes a valid investigation AND • Describes ways in which accuracy AND reliability could be improved	3 – 4
• Describes a valid investigation OR • Describes ways in which accuracy OR reliability could be improved	1 – 2

Sample Answer:
Set up a series of test tubes containing known quantities of milk and rennin. Heat each of the test tubes to different temperatures and time how long it takes the milk to clot. The accuracy of the experiment could be improved by using a temperature probe to record the temperature rather than a conventional laboratory thermometer and the reliability could be improved by repeating each experiment several times and averaging the times for the milk to clot at particular temperatures.

(e) (7 marks)
Outcomes Assessed: H5, H7, H8, H13
Targeted Performance Bands: 2-6

Criteria	Marks
• Identifies the muscle cells used for light or endurance exercise AND • Justifies how this type of cell is used for this purpose	6 – 7
• Identifies the muscle cells used for light or endurance exercise AND • Explains how this type of cell is used for this purpose	4 – 5
• Identifies the muscle cells used for light or endurance exercise AND • Describes, briefly, how this type of cell is used for this purpose	2 – 3
• Identifies the muscle cells used for light or endurance exercise	1

Sample answer:
Type I muscles are used for light or endurance exercise. These are slow twitch muscle cells that have a rich supply of blood and therefore, oxygen. These muscles therefore, mostly undergo aerobic respiration since they contain many mitochondria and the process of oxydative phosphorylation is used to obtain most of their ATP. Endurance runners have a highly developed ability to produce ATP aerobically and thus are able to produce the maximum 38 molecules of ATP from complete aerobic respiration.
[Adapted from – Irwin, D et al (2001). *Chemistry Contexts 2 CD-ROM*, Pearson Education Australia]

Option – The Chemistry of Art

Question 31 (a) (i) (1 mark)
Outcome Assessed: H6
Targeted Performance Bands: 2-3

Criteria	Mark
• Name or formula of stated colour is correct	1

Sample Answer:
White – hydrated aluminium silicate ($Al_2O_3.2SiO_2.2H_2O$)

Question 31 (a) (ii) (2 marks)
Outcomes Assessed: H1, H6
Targeted Performance Bands: 3-4

Criteria	Marks
• Describes the process required to produce a paint, including the addition of the mineral to a medium in which it is insoluble	2
• Identifies an example of a liquid medium used to produce a paint OR • Identifies a liquid medium required to make a paint	1

Sample Answer:
They would have mixed the pigment, the white kaolin (formula given above), with an insoluble liquid medium such as plant gums or resins.

(b) (i) (3 marks)
Outcome Assessed: H6
Targeted Performance Bands: 2-4

Criteria	Marks
• Detailed description of the technique	3
• Description of the technique	2
• Describes the technique as using a laser to vapourise a sample of the painting	1

Sample Answer:
This technique includes the vaporisation of a sample via laser, excitation of the atoms by a pair of electrodes, and the subsequent production of an emission spectra which is then analysed.

(b) (ii) (2 marks)
Outcomes Assessed: H4, H11
Targeted Performance Bands: 3-6

Criteria	Marks
• Contrasts the destructive nature of laser microspectral analysis to the non-destructive nature of reflectance spectra analysis and relates this to the desire to retain the quality of the art work being restored	2
• Identifies that laser microspectral analysis is a destructive analytical method OR • Identifies observation of reflectance spectra is a non-destructive analytical method	1

Question 31 (c) (i) (1 mark)
Outcome Assessed: H6
Targeted Performance Bands: 3-4

Criteria	Marks
• Correct response (states not required) – $Na(g) \rightarrow Na^+(g) + e^-$	1

(c) (ii) (3 marks)
Outcomes Assessed: H6, H12
Targeted Performance Bands: 3-5

Criteria	Marks
• Relates the data on ionisation energy to the electron configuration of sodium, explaining the low 1st ionisation energy, the steady increase from the 2nd to the 9th, and the large increase in the 10th ionisation energy	3
• Relates the data on ionisation energy to the electron configuration of sodium, explaining the large increase in the 10th ionisation energy	2
• Identifies ionisation energy is related to the electron configuration of an atom OR • States the electron configuration of sodium	1

(d) (6 marks)
Outcomes Assessed: H6, H12
Targeted Performance Bands: 2-6

Criteria	Marks
• Describes a method, including suitable reagents, to change the oxidation state of the transition metal AND • Includes a suitable balanced half-equation or complete equation AND • Identifies the oxidation state of the metal in the product and the associated colour	6
• Describes a method, including suitable reagents, to change the oxidation state of the transition metal AND • Identifies the colour change OR • Species produced in the reaction	4 – 5
• Identifies the oxidation state of the named transition metal in one species containing the metal AND • The associated colour	2 – 3
• Identifies a transition metal (OR species containing a transition metal) that could have been investigated	1

Sample Answer:
The yellow VO_2^+ [Vanadium(V)] reacts with zinc in dilute hydrochloric acid to undergo a series of reductions to blue VO^{2+} [Vanadium(IV)] to green V^{3+} [Vanadium(III)] and finally violet V^{2+} [Vanadium(II)]. The relevant equations representing the reduction of vanadium are:

$VO_2^+(aq) + e^- + 2H^+(aq) \rightarrow VO^{2+}(aq) + H_2O(l)$ product – blue VO^{2+} [Vanadium(IV)]
$VO^{2+}(aq) + e^- + 2H^+(aq) \rightarrow V^{3+}(aq) + H_2O(l)$ product – green V^{3+} [Vanadium(III)]
$V^{3+}(aq) + e^- \rightarrow V^{2+}(aq)$ product – violet V^{2+} [Vanadium(II)]

Source: Irwin, D et al (2001), *Chemistry Contexts 2*, CD Rom : Pearson Education Australia

(e) (7 marks)

Outcomes Assessed: H1, H6, H13

Targeted Performance Bands: 2-6

Criteria	Marks
• Discusses the successes AND limitations of the Bohr model in explaining the emission of hydrogen AND more complex elements	6 – 7
• Describes the existence of emission spectra of elements and applies Bohr's model to explain the phenomena	4 – 5
• Describes the major features of the Bohr model, including the existence of principle energy levels or shells which contain a maximum number of electrons AND • Describes how electrons change levels by absorption or emission of exact quanta of energy	2 – 3
• Identifies the Bohr model is concerned with location of electrons in atoms	1

Sample Answer:

Bohr's atomic model consisted of a central nucleus with electrons orbitting the nucleus in particular energy levels. He proposed that the electrons could orbit in a particular energy level without radiating energy. He further proposed that only particular orbits corresponding to particular energy levels were permitted. Bohr suggested that each line in the emission spectrum of an element corresponds to the transition of an electron from one energy level to another, lower energy level. If these energy transitions are equivalent to frequencies in the visible region, then the spectral lines will be seen using a spectroscope. Bohr's model, however, was not as reliable for predicting the emission spectra of elements with more than one electron, (i.e. any other element!) nor could it explain the fact that one emission line, on closer inspection, was in fact several lines that were very close together.

Option – Forensic Chemistry

Question 32 (a) (i) (1 mark)
Outcome Assessed: H9
Targeted Performance Bands: 2-3

Criteria	Mark
• Correct definition mentions X-rays and the emission of electrons	1

Sample Answer:
Electron spectroscopy is a surface analysis technique in which an X-ray beam is focussed onto a solid surface, causing electrons to be emitted.

(a) (ii) (2 marks)
Outcome Assessed: H9
Targeted Performance Bands: 3-4

Criteria	Marks
• Identifies a solid sample whose surface could be analysed by electron spectroscopy AND • Describes how this information could be used by a forensic scientist	2
• Identifies a solid sample whose surface could be analysed by electron spectroscopy	1

Sample Answer:
The chemical composition of solid samples such as paint fragments can be analysed by electron spectroscopy. Differences in the energies of the emitted electrons provide information about the elements that are present in a sample, as well as the chemical states in which they are found.

(NB. Analyses that could be performed by electron spectroscopy include the measurement of microscopic features such as fractures and microstructures, evaluating thin coatings, and surface contamination.)

(b) (i) (2 marks)
Outcomes Assessed: H3, H6
Targeted Performance Bands: 2-4

Criteria	Marks
• Describes the appearance of emission spectra as being made up of a series of lines over a range of wavelengths of light AND • Identifies that comparison of the position of lines in the line emission spectra of individual elements with those in the mixed emission spectrum of an analysed mixture allows determination of the elements contained in the sample	2
• Describes the appearance of emission spectra as being made up of a series of lines over a range of wavelengths of light OR • Identifies that comparison of the position of lines in the line emission spectra of individual elements with those in the mixed emission spectrum of an analysed mixture allows determination of the elements contained in the sample	1

Sample Answer:
The emission spectra of an element is a series of lines which is spread over a range of wavelengths of light in a characteristic pattern. By comparing the position of lines in the line emission spectra of individual elements with those in a mixed emission spectrum, it is possible to determine which elements are present in an analysed mixture.

(b) (ii) (3 marks)
Outcomes Assessed: H6, H7
Targeted Performance Bands: 3-6

Criteria	Marks
• Identifies that different wavelengths of light are related to different amounts of energy released when electrons move to lower energy levels AND • Identifies that each element has a different number of electrons, spread over different energy levels, which results in a unique spectrum	3
• Identifies that different wavelengths of light are related to different amounts of energy released when electrons move to lower energy levels OR • States that energy is released when electrons move to lower energy levels AND • That each element has a different number of electrons	2
• States that energy is released when electrons move to lower energy levels OR • States that each element has a different number of electrons	1

Sample Answer:
When electrons move between energy levels, energy that can be seen as a particular wavelength of light is released. Different amounts of energy are released depending on between which energy levels electrons are moving. Since every element contains a characteristic number and arrangement of electrons, it can be characterised by a unique spectrum made up of the wavelengths that are emitted when its electrons move.

Question 32 (c) (i) (2 marks)
Outcomes Assessed: H9, H12
Targeted Performance Bands: 2-4

Criteria	Marks
• One of the illustrated functional groups is identified correctly AND • A class of organic compounds which contains this group is identified	2
• One of the illustrated functional groups is identified correctly	1

Sample Answer:
Atropine contains a hydroxyl group, which is a common feature of carbohydrates.

(c) (ii) (2 marks)

Outcomes Assessed: H10, H13

Targeted Performance Bands: 3-5

Criteria	Marks
• Correctly determines the molecular formulae of atropine - $C_{17}H_{23}O_3N$, and cocaine - $C_{17}H_{21}O_4N$. AND • States that cocaine and atropine are not isomers since isomers have the same molecular formulae and different structural formulae.	2
• Identifies different numbers of atoms of one particular element are given as evidence of different molecular formulae OR • Attempts to determine the molecular formulae AND • States that cocaine and atropine are not isomers since isomers have the same molecular formulae and different structural formulae.	1

Sample Answer:

The molecular formula of atropine is $C_{17}H_{23}O_3N$, and that for cocaine is $C_{17}H_{21}O_4N$.
These compounds are not isomers because they differ in both their molecular and structural formulae.

(d) (6 marks)

Outcomes Assessed: H3, H9, H12

Targeted Performance Bands: 2-6

Criteria	Marks
• Describes in some detail a separation technique for the separation of amino acids AND • Describes amino acid molecules, identifying differences between amino acids which enable them to be separated from one another AND • Justifies the choice of the described technique over another named technique (eg accuracy and reliability better in electrophoresis, while chromatography is more economical)	5 – 6
Any TWO of the following: • Describes in some detail a separation technique for the separation of amino acids • Describes amino acid molecules, identifying differences between amino acids which enable them to be separated from one another • Justifies the choice of the described technique over another named technique (eg accuracy and reliability better in electrophoresis, while chromatography is more economical)	3 – 4
• Identifies a separation technique for the separation of amino acids OR • Describes amino acid molecules	1 – 2

Sample Answer:

Paper chromatography may be used to separate amino acids. Paper which has been soaked in water and 'spotted' with the amino acid samples is placed with one end in a less-polar solvent. The differences in the polarity of the amino acid molecules allows them to be separated.
All amino acids contain an amine and a carboxylic acid group. However each of the 20 amino acids has a different R group, and these groups may be polar (-SH) or non-polar ($-CH_3$). More polar amino acids dissolve in the polar stationary phase well and therefore travel relatively slowly. Less polar amino acids dissolve well in the less polar mobile phase and therefore travel relatively quickly with the mobile phase. The ninhydrin reaction is used to make the separated amino acid samples visible. Another technique which may be used to separate a mixture of amino acids is electrophoresis, however the advantage of paper chromatography is that it is much more economical.

(e) (7 marks)

Outcomes Assessed: H3, H4, H5, H9, H13, H14

Targeted Performance Bands: 2-6

Criteria	Marks
• Outlines a range of community views over the use of DNA fingerprinting in forensic cases by identifying several ethical issues associated with the use of DNA AND • Justifies the effect of sample contamination on DNA fingerprinting and identifies some way in which errors may occur in this type of analysis	6 – 7
• Outlines a range of community views over the use of DNA fingerprinting in forensic cases by identifying several ethical issues associated with the use of DNA OR • Justifies the effect of sample contamination on DNA fingerprinting and identifies some way in which errors may occur in this type of analysis OR • Describes several ethical issues associated with the use of DNA and describes the issue of contamination/errors in genetic analysis	4 – 5
• Describes several ethical issues associated with the use of DNA OR • Describes contamination/errors in genetic analysis	2 – 3
• Identifies that the technique of DNA fingerprinting is used by forensic chemists OR • Identifies that each person's DNA is unique OR • Identifies an ethical issue associated with the analysis of genetic information	1

Sample Answer:

Forensic scientists use the technique of DNA fingerprinting as a technique for the analysis of DNA that allows identification of individuals. DNA fingerprinting is a very powerful tool because every person's non-coding DNA is unique. Therefore this technique can be used to convict murderers and rapists, or clear suspects from very small samples of biological material.

The samples which may be used for DNA fingerprinting include blood, semen, saliva and hair. Generally, this procedure is not affected by sample contamination because the process involves purifying DNA from an impure sample in the first place.
The results of DNA analysis are generally considered infallible, and because the implications of a false analysis are so severe, it is worth remembering that human error still may occur during analysis, or even that samples such as hair could be 'planted' at a crime scene. For these reasons, it is important that DNA evidence is presented in conjunction with other substantiating evidence. Precautions such as the collection of more than one sample could increase confidence in the accuracy of results.

In many countries databases of known offenders have been established. A DNA data bank could consist of the results of DNA profile analyses, or even the DNA samples themselves. Many people disagree with keeping databases on people's DNA because it is a breach of their privacy. Another ethical issue is raised by storing DNA samples is that there would be a great temptation to routinely screen the samples for known genetic diseases. The decision to screen for a genetic disease is a personal one, and many individuals may not wish to know that they have a disease.